

A Simple Computer Model for Evaluating Coastal Inlet Hydraulics

by
William N. Seelig



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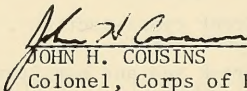
PREFACE

This report describes a method for estimating inlet velocities, discharge, and bay levels based on the numerical model of Seelig, Harris, and Herchenroder (in preparation, 1977). This method for predicting inlet hydraulics is not discussed in the Shore Protection Manual (SPM) (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1975). The work was carried out under the General Investigation of Tidal Inlets (GITI) of the U.S. Army Coastal Engineering Research Center (CERC).

The report was prepared by William N. Seelig, Research Hydraulic Engineer, under the general supervision of Dr. R.M. Sorensen, Chief, Coastal Structures Branch.

Comments on this publication are invited.

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Colonel, Corps of Engineers
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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.39	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.8532	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.1745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins ¹

¹To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9) (F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9) (F - 32) + 273.15$.

SYMBOLS AND DEFINITIONS

A_{bay}	bay surface area (square feet)
A_0	bay surface area at datum (square feet)
$C1, C2$	coefficients to evaluate Manning's n (dimensionless)
d_{bay}	depth of bay (feet)
d_{max}	maximum water depth in inlet (feet)
D	stillwater depth (feet)
g	acceleration of gravity (32.2 feet per second squared)
h_b	water level in bay (feet)
h_s	water level in sea (feet)
L_{bay}	length of bay (feet)
L_{in}	length of inlet (feet)
T_F	forcing wave period (seconds)
t	time step used in model (seconds)
β	bay surface area variation parameter (dimensionless)

A SIMPLE COMPUTER MODEL FOR EVALUATING COASTAL INLET HYDRAULICS

by
William N. Seelig

I. INTRODUCTION

This report describes a method for estimating coastal inlet velocities, discharge, and bay levels using the simple numerical model of Seelig, Harris, and Herchenroder (in preparation, 1977)¹. The model can be used for sea level fluctuations caused by astronomical tides, storm surges, seiches, or tsunamis. A digital computer program is used because of the large number of computations. A run on a CDC 6600 computer generally costs less than \$5 for a tidal cycle.

II. PREDICTING INLET HYDRAULICS

1. Systems Modeled with Computer Program.

An inlet-bay system consists of a "sea" (e.g., ocean or lake) connected to a "bay" by one or more inlets (Fig. 1). The computer model will predict bay levels, inlet velocities, and discharge as a function of time given the geometry of the system and the water level fluctuations in the sea. It is assumed that the sea is much larger than the inlet and bay and that the bay is large compared to the inlet.

The model is designed for systems where the bay water level rises and falls uniformly throughout the bay. This occurs when the wavelength in the bay is much longer than the longest axis of the bay:

$$T_F \sqrt{gd_{bay}} \gg L_{bay}, \quad (1)$$

where

T_F = forcing wave period

g = acceleration of gravity

d_{bay} = depth of bay

L_{bay} = length of bay

2. Procedures for Use of Computer Program.

Step 1. Evaluate the inlet geometry by using maps, charts, hydrographic surveys, and dredging records to determine the depth of water throughout the inlet. The side slope of the inlet at mean water level

¹SEELIG, W.N., HARRIS, D.L., and HERCHENRODER, B.E., "A Spatially Integrated Numerical Model of Inlet Hydraulics," GITI Report 14, U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va., and U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss. (in preparation, 1977).

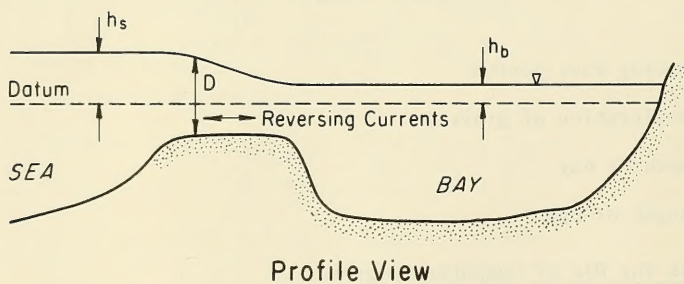
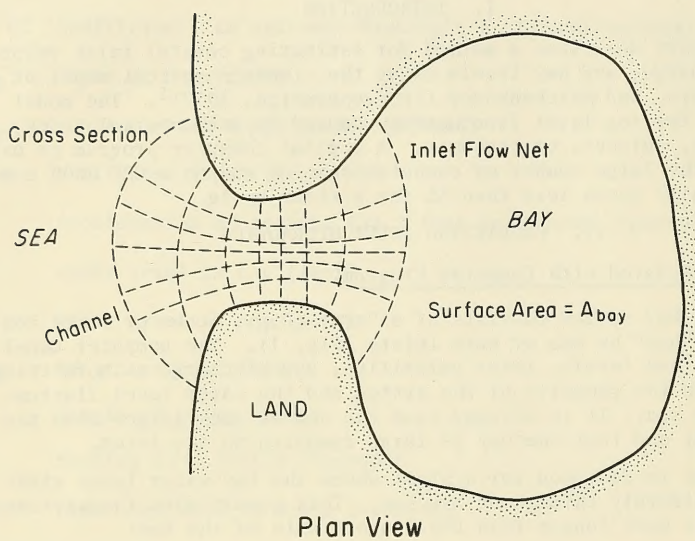


Figure 1. Inlet-bay system.

should also be measured. Whenever possible, obtain this information for the time of interest because inlets frequently change shape, especially during major storms.

Step 2. Construct a flow net (series of cross sections and channels) for the inlet to represent the model grid (Fig. 1). The flow net and inlet discharge are used to determine bottom friction throughout the inlet. The flow net is drawn by approximating the average path (channel) that water follows during ebb flow and floodflow. Channel boundaries are drawn along these paths for up to seven channels. A simple inlet with constant depth and width may be modeled with one or two channels. Complex inlets require approximately three to seven channels. Channels should have the smallest spacing in deep parts of the inlet where flow will be highest. Up to eight cross sections should then be drawn perpendicular to the channels. The first cross section in the sea and the last cross section in the bay should have cross-sectional areas 10 times larger than the minimum cross-sectional area. Cross sections should be drawn with the narrowest spacing near the minimum cross-sectional area section where friction in the inlet will be high.

Step 3. Measure the surface area of the bay at the mean water level, A_0 , from charts or aerial photos. For most bays the surface area changes as the bay water level rises and falls because sections are flooded at high water levels. If the bay area change is significant, a bay area variation parameter, β , is used to account for area of the bay, A_{bay} , at any water level in the bay, h_b , using the relation:

$$A_{bay} = A_0(1 + \beta h_b), \quad (2)$$

where A_0 is the bay surface area at datum, usually mean low water (MLW), mean sea level (MSL), or mean water level (MWL).

Step 4. Specify the seawater level fluctuation as a function of time for the period of interest. Tide tables will give an estimate of the astronomical tide. Water levels can also be measured by a tide gage and stilling well (Seelig, 1977)². Corps of Engineers and National Oceanic and Atmospheric Administration (NOAA) gages located at numerous points along the coast may also provide the desired water level information. In this computer program either the tide may be expressed as a sinusoidal wave with a period and amplitude or the levels may be described by instantaneous sea level measurements at a constant sampling rate.

Step 5. Determine the time step of input to the model for use in computations. As a lower limit, the time step, Δt , should be:

$$\Delta t = \frac{L_{in}}{\sqrt{gd_{max}}}, \quad (3)$$

²SEELIG, W.N., "Stilling Well Design for Accurate Water Level Measurement," TP 77-2, U.S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va., Jan. 1977.

where L_{in} is the length of the inlet and d_{max} is the maximum water depth in the inlet. A longer time step can be used for most tidal inlets, and as an upper limit, the time step should be one-hundredth of the forcing wave period.

Step 6. Document all input data using the computer format shown in the appendix. As a first estimate, set the flood and ebb entrance and exit loss coefficients to equal one (CDF = 1.0 and CDE = 1.0). As a first approximation, Manning's n can be evaluated by the relation:

$$n = C1 - C2 D, \quad (4)$$

where D is the local inlet stillwater depth. For depths greater than 4 feet and less than 30 feet, $C1 = 0.03777$ and $C2 = 0.000667$; for depths less than 4 feet, $C1 = 0.0550$ and $C2 = 0.005$. The n for each grid may be different if $C2 \neq 0$.

Step 7. For use with periodic forcing, run the program for several sinusoidal cycles having the period and amplitude of the long wave of interest to approximate the hydraulic characteristics of the inlet-bay system. A sinusoidal tide is specified in the model by giving the forcing period, T , in hours and the wave amplitude, A_o , in feet, on card type 3 and by setting NPTS = 0 on card type 8 of input to the program INLET. Set ITABLE = 1 to obtain tables of instantaneous hydraulics at points throughout the water level cycle and set IPLOT = 1 to obtain a plot of predicted inlet velocities and discharge at sequential bay levels. These outputs will indicate the importance of the terms in the equation of motion describing water motion in the inlet. If temporal acceleration is small during most of the water level cycle, then startup transients will be small and the first or second cycle will contain little transient effect (NCYCLES = 1 or 2 in input data). However, if temporal acceleration is significant during more than 25 percent of the cycle, approximately four cycles of model operation are required to eliminate startup transient effects (NCYCLES = 4). For aperiodic use such as with storm surges or rapidly varying wave size (e.g., tsunamis), run the model for the water level for approximately 10 hours before the time of interest to build up initial conditions in the model similar to the prototype.

Step 8. Calibrate the computer model by varying Manning's n or flood- and ebb-loss coefficients. The seawater level fluctuation can be specified as a sinusoidal wave or in terms of an equal time series. For an equal time series, start and stop the series when the seawater level is at zero so that one or more complete cycles are described. Use at least 20 points to describe each cycle. The sampling interval in minutes, TDEL, and the number of points, NPTS, must be specified on card type 8 and the water level data on card type 9.

The model is calibrated using short periods of field observations by first comparing observed and predicted mean water velocities, if available, at the minimum cross-sectional area region of the inlet. If the predicted velocities are higher or lower than observed, then the value

of n can be increased or decreased accordingly. When the computer model has been satisfactorily calibrated to predict inlet velocities, predicted bay water levels should be checked against measurements to assure that levels are being modeled correctly. If inlet velocities are not available, bay levels can be used to calibrate the model.

Step 9. If additional prototype data are available, these data should be used to verify that the model adequately predicts inlet and bay hydraulics.

Step 10. At this point the computer program is ready to use for prediction. Examples of the use of the computer program are presented in the following section. Input and output data, and computations are in U.S. Customary units.

III. EXAMPLES OF COMPUTER PROGRAM PREDICTION

1. Cabin Point Creek, Virginia.

Cabin Point Creek is a shallow natural tidal inlet that connects a bay to the lower Potomac River (Fig. 2) where the mean tidal range is approximately 1.5 feet.

In this example, the model was calibrated with prototype river and bay levels and the calibrated model was then used to predict inlet velocities, discharge, and bay level for a second inlet added to the system. The procedures for using the model are:

(a) The inlet cross section was measured (Fig. 3) on 24 May 1976, and is assumed to be representative of the 1,900-foot-long inlet.

(b) The inlet is modeled using a grid system of three channels and two identical cross sections (Fig. 3) at either end of the inlet.

(c) The bay area, A_o , measured from a $7\frac{1}{2}$ -minute U.S. Geological Survey (USGS) topographic map, was 3.5×10^6 square feet. For an increase in bay water elevation of 0.25 foot, the bay surface area increases approximately 5 percent because of marsh flooding. The bay area variation parameter, β , can be determined from this information using equation (2), rearranged as:

$$\beta = \frac{1}{h_b} \left(\frac{A_{bay}}{A_o} - 1 \right) , \quad (5)$$

or, in this case,

$$\beta = \frac{1}{0.25} (1.05 - 1) = 0.2$$

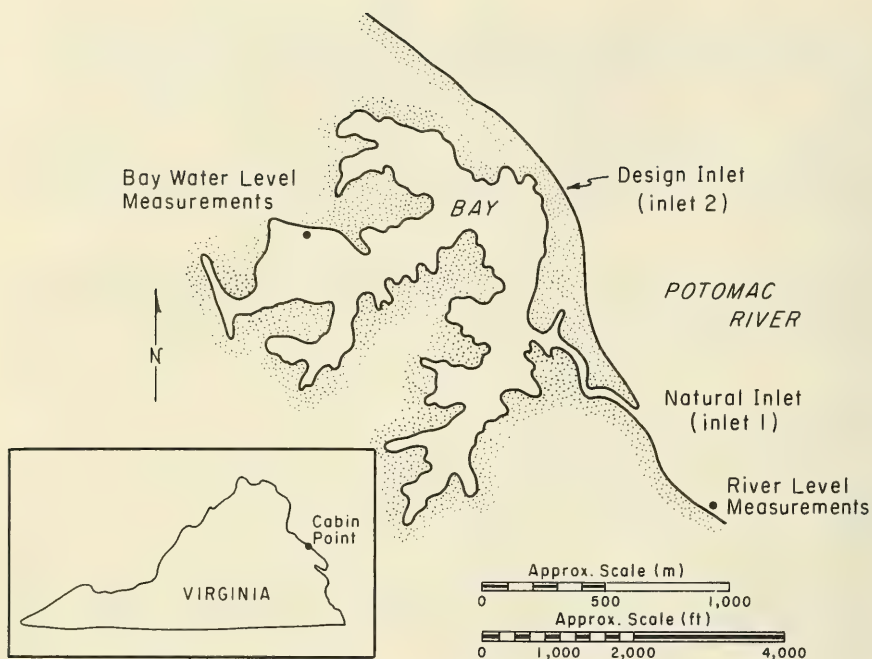


Figure 2. Cabin Point Creek, Virginia.

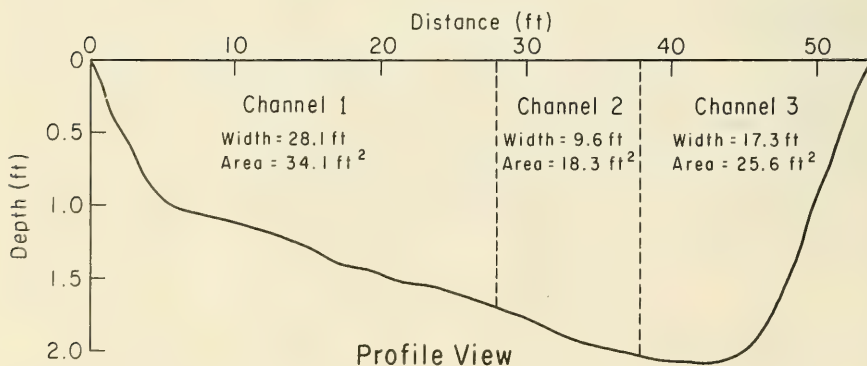


Figure 3. Cabin Point Creek cross section.

(d) River water levels were measured at 30-minute intervals using a stilling well located near the inlet mouth (Fig. 2).

(e) The time step was estimated as:

$$\Delta t = \frac{1900}{\sqrt{32.2 \times 2}} = 250 \text{ seconds}$$

(f) Loss coefficients were specified as CDF = CDE = 1.0, and Manning's n was estimated as $n = 0.055 - 0.005 D$ (recommended for depths less than 4 feet).

(g) A preliminary computer run using a sinusoidal river tide showed that the inlet is controlled by friction effects and that temporal acceleration is not important.

(h) The model was then run using the measured river water levels to force the model (Fig. 4). It was determined that the model adequately predicted bay levels.

(i) No additional prototype data are available for verification of the model.

(j) The model is now available to use for predictions of inlet hydraulics. In this example, a second inlet (inlet 2), is being considered for this site, so the model is used to predict hydraulics for the system with two inlets (Fig. 2). Procedures (a) and (b) are repeated for the second inlet. In this case, the second inlet is modeled by one channel and two cross sections so that the inlet has a length of 300 feet, a width of 50 feet, and a depth of 4 feet. These inlet data are put into the computer format, added to the program deck for the natural inlet, and re-run to predict conditions for the proposed two-inlet system. The numerical model predicts that addition of the second inlet would increase the tidal range and the tidal prism in the bay and would cause water velocities in inlet 1 to decrease (see Table).

Table. Predicted Cabin Point Creek hydraulics.

Tide	24 and 25 May 1976	Model prediction for second inlet	
	Inlet 1	Inlet 1	Inlet 2 ¹
Bay (range in ft)	0.36	1.49	1.49
Ebb (maximum velocity in ft/s)	-0.6	-0.3	-1.3
Flood (maximum velocity in ft/s)	0.9	0.3	1.7

¹L = 300 feet, B = 50 feet, D = 4 feet.

NOTE: Tidal range in the sea is 1.49 feet.

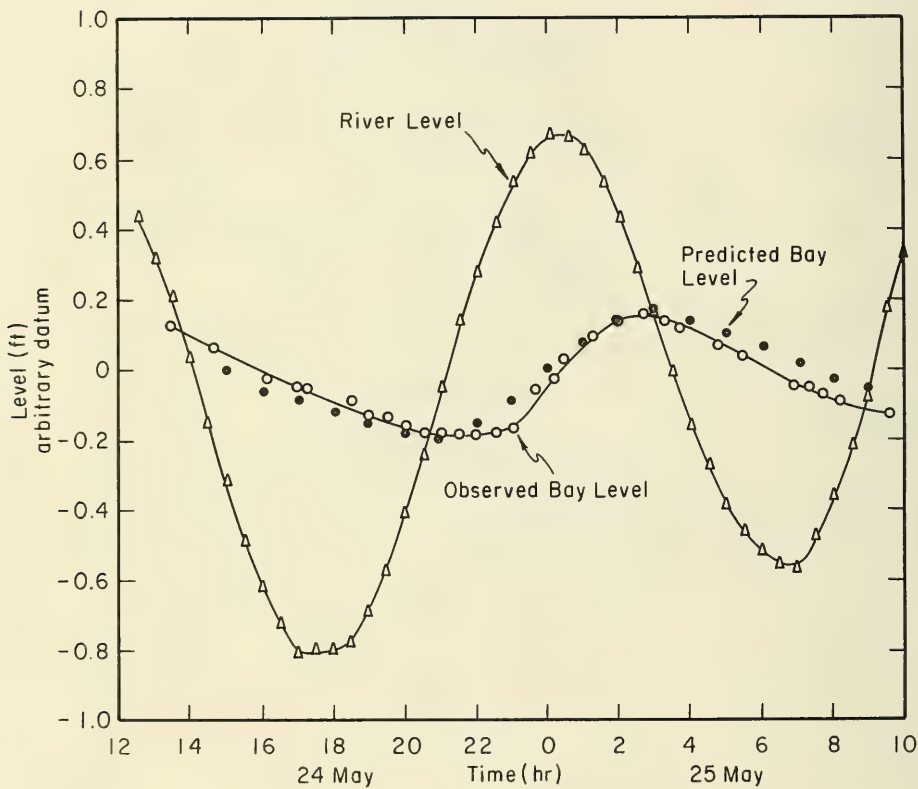


Figure 4. Cabin Point Creek sea and bay levels.

2. Pentwater Inlet, Michigan.

Pentwater Inlet is an example of a Great Lakes inlet controlled by vertical-walled jetties along the entire 2,000-foot channel (Fig. 5). Meteorologically generated seiches of Lake Michigan are the primary water level fluctuations causing reversing currents in the inlet. A model of Pentwater will be calibrated and used to estimate hydraulic response of the inlet to simultaneous lake seiching and river inflow. The procedures used in this modeling are:

(a) A hydrographic survey of the inlet is used to describe the inlet geometry.

(b) The inlet is modeled using one channel and six cross sections.

(c) The bay surface area, measured from a hydrographic chart, is 1.81×10^7 square feet. The bay area does not change with bay water level because the bay has steep-sided slopes, so $\beta = 0$.

(d) Lake Michigan water level measurements used to force the model were taken at 5-minute intervals on a tower located adjacent to Pentwater Inlet.

(e) The model time step used is:

$$\Delta t = \frac{2000}{\sqrt{32.2 \times 15}} = 90 \text{ seconds}$$

(f) Loss coefficients were specified as $CDE = CDF = 1.0$, and Manning's n was estimated by $n = 0.03777 - 0.000667 D$ (recommended for depths greater than 4 feet and less than 30 feet).

(g) A preliminary run showed that temporal acceleration is an important term in the inlet equation of motion for Pentwater Inlet (Fig. 6). Therefore, several forcing cycles of model operation before the time of interest are necessary to eliminate transient terms due to startup conditions.

(h) The model is calibrated by using Lake Michigan levels to force the model. An initial run showed that predicted bay level fluctuations adequately modeled observed levels (Fig. 7).

(i) The model was not verified.

(j) The model was used to predict inlet velocities, discharge, and bay levels for a 2-hour forcing wave with an

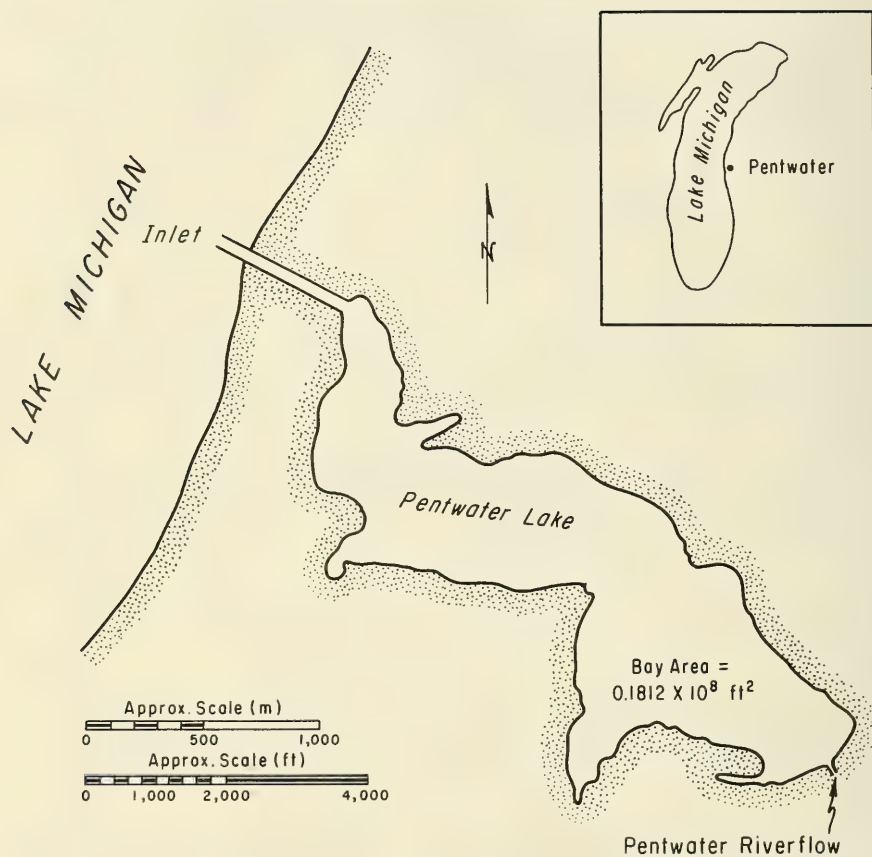


Figure 5. Pentwater Inlet, Michigan.

Importance of Terms in the Equation of Motion
(normalized by the largest term)

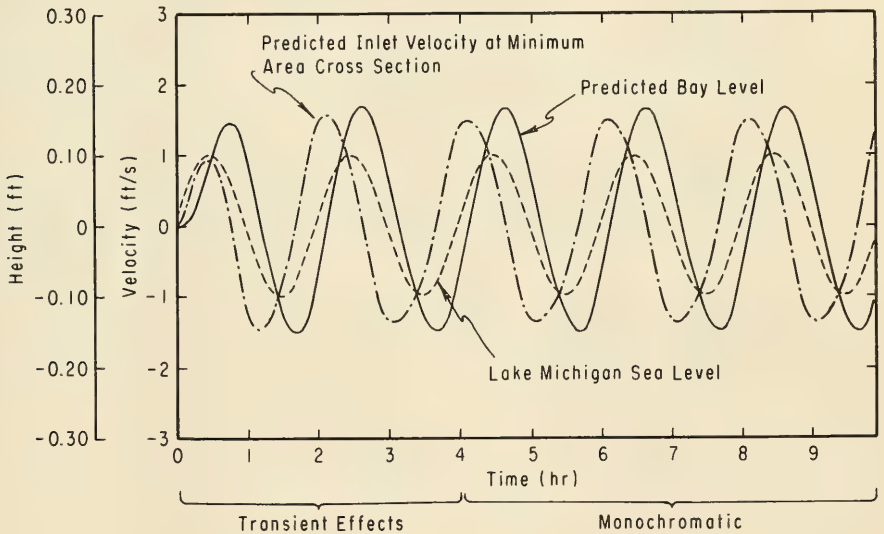
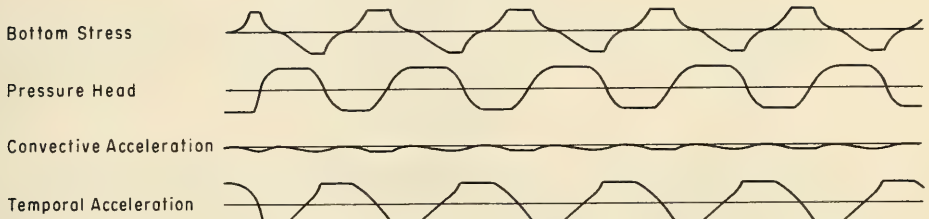


Figure 6. Pentwater Inlet model prediction of monochromatic forcing (for a 2-hour wave with a 0.1-foot amplitude).

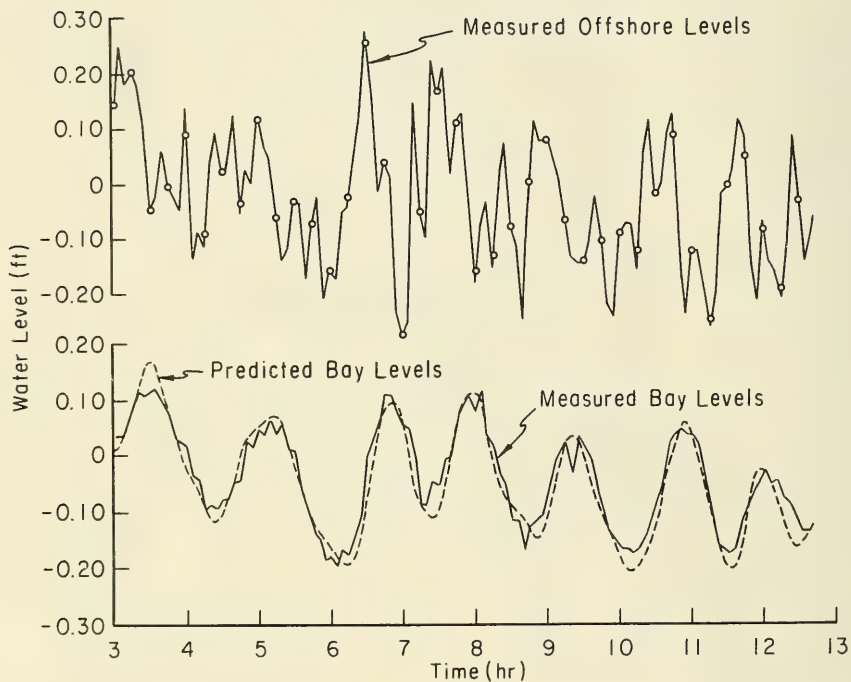


Figure 7. Pentwater Inlet model calibration.

amplitude of 0.10 foot and a discharge into Pentwater Lake of 2,800 cubic feet per second from the Pentwater River. The model predicted an average bay water surface elevation of 0.13 foot higher than the mean lake level, a bay water level fluctuation range of 0.25 foot, and a prism of water of 4.6×10^6 cubic feet caused by the seiche (Fig. 8). The inlet would always be in ebb flow due to river influence with a maximum velocity of -2.7 feet per second and a minimum velocity of -0.1 foot per second. Head, friction, and temporal and convective acceleration are important in the inlet equation of motion.

IV. SUMMARY

A computer program (INLET) based on a numerical model (Seelig, Harris, and Herchenroder, in preparation, 1977)¹ is presented for prediction of hydraulics where one or more inlets connect a bay to a sea. Two examples are given: (a) A tidal inlet forced by an astronomical tide where inlet channel friction is the dominant term in the equation of motion; and (b) a Great Lakes inlet with river inflow forced by lake seicheing where head, friction, and temporal and convective accelerations are important at different points in the water level fluctuation cycle. The model can also be used for forcing other water level fluctuations, such as from storm surges or tsunamis.

Another computer program (INLET2) is available for more complex systems of interconnected inlets, bays, and seas. INLET2 is an expanded version of INLET. Documentation and computer card decks for INLET2 are available from the Automatic Data Processing Division (CERDP), Coastal Engineering Research Center (CERC).

Details on model development and application, including additional examples, are reported by Seelig, Harris, and Herchenroder (in preparation, 1977)¹.

¹SEELIG, HARRIS, and HERCHENRODER, op. cit., p. 7.

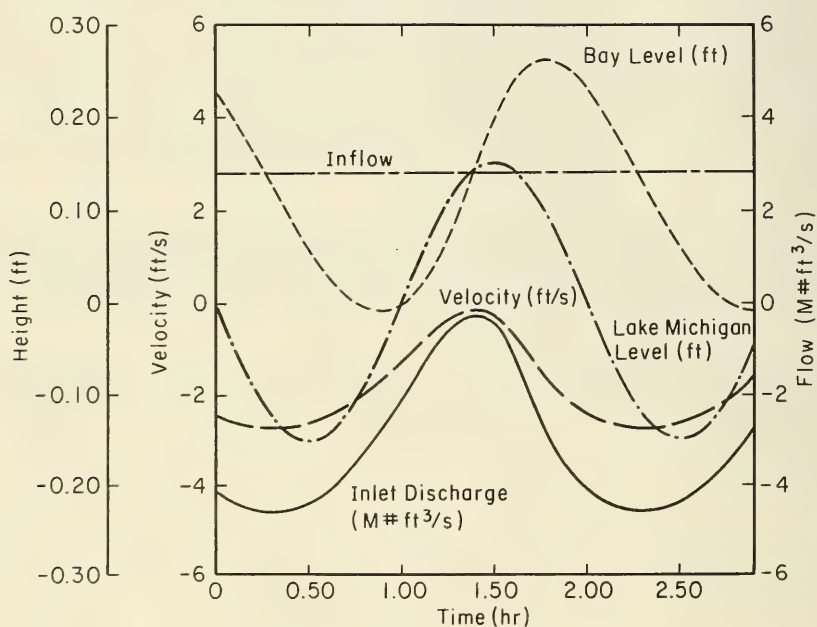


Figure 8. Predicted Pentwater Inlet velocities, discharge, bay levels, and relative magnitude of terms in the equation of motion.

APPENDIX

COMPUTER PROGRAM DOCUMENTATION (INLET)

1. Program Description.

The numerical model to predict inlet hydraulics is programmed in FORTRAN for a CDC 6600 computer. The simultaneous differential equations are solved by a variable time step Runge-Kutta-Gill marching procedure. The organization of the computer program is shown in Figure A-1. A brief description of each routine follows:

INLET is the main routine which controls input-output and calls subroutines to execute a specific task. Figure A-1 summarizes control throughout the program. The program is organized to accept up to three inlets connecting the bay to the sea, up to seven channels for each inlet, and up to eight cross sections (seven grids long).

Subroutine HELM uses an iterative method of estimating the natural pumping period or Helmholtz period, T_H' , for the inlet-bay system by neglecting friction in the inlet to give:

$$T_H' = 2\pi \sqrt{\frac{(L_n + L') A_{bay}}{gA_c}}$$

where L' is added inlet length due to radiation, and where L' is given by:

$$L' = \frac{-B}{\pi} \ln \left(\frac{\pi B}{\sqrt{gd} T_H} \right)$$

Subroutine RKGS is a routine to solve simultaneous differential equations. This subroutine was adapted from the scientific subroutine package.

Subroutine SETEQ evaluates the right-hand side of the equation of motion, one for each inlet, and the continuity equation between the inlet and bay for each step. This routine also evaluates the relative rank of the four terms in the equation of motion for flow in each inlet.

Subroutine LEVEL determines the water level in the grids at each time step. The routine interpolates the level between the sea and bay based on the relative amount of friction in each grid cell.

Subroutine TPWRTE writes hydraulic results from each time step on a tape or disc, so that this information can be used later by the output routines.

Subroutine TABLE outputs a table of instantaneous hydraulics each time the routine is called.

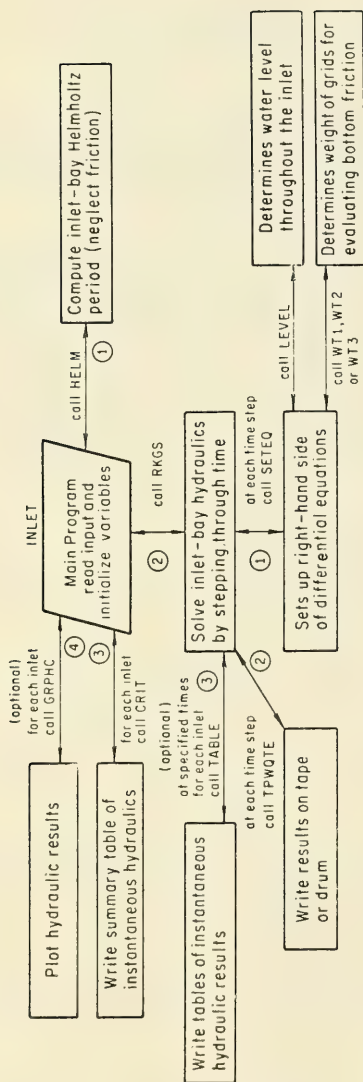


Figure A-1. Flow chart of the computer program INLET.

Subroutine SEA determines the water level in the sea as a function of time either for a given sine wave or by interpolating equal time-series data.

Subroutine WT1 determines the grid-weighting function by assuming that the flow is distributed across each section so that friction is minimized. This routine allows flow to cross channel boundaries, but assumes that this flow will be small, so the flow is neglected in the equation of motion. This weighting function is recommended for general use.

Subroutine WT2 is similar to WT1, except that flow is not allowed to cross channel boundaries and that flow is distributed in each channel so that friction is minimized.

Subroutine WT3 determines the weighting function so that flow is distributed equally in all grids. This is generally unrealistic, since it will be difficult to visually draw this grid system. However, this routine is useful since it provides an upper limit on frictional effects and therefore gives a lower limit of bay levels and inlet velocities. This weighting can be used to model simple geometry inlets where only one channel is used to represent the inlet.

Subroutine CRIT prints a table of critical instantaneous hydraulics (i.e., at high water, low water, maximum velocity, and maximum discharge). This table is determined by storing a summary of conditions for each time step, then scanning this list for critical values.

Subroutine GRPHC plots mean inlet hydraulics by scaling hydraulics in storage and plotting the time interval requested on a digital x-y pen plotter.

Subroutine READIN is used by GRPHC to read data in storage and scale values for plotting.

2. Program Input.

The computer program (INLET) requires the following input of one deck for each inlet-bay system:

Card type	Variables	Format	Description
1	ALABL1	4A10	first line of title
	ALABL2	4A10	second line of title
2		5I10, 2F10.5, I10	
	NINLET		number of inlets
	NCYCLES		number of cycles
	IPL0T		IPL0T = 1 for plot of results

Card type	Variables	Format	Description
	IWT		weighting type IWT = 1 flow distributed to minimize (1 in card col. 40)
	ITABLE		ITABLE = 1 for tables of instantaneous hydraulics
	C1, C2		Manning's n evaluated by: $n = C1 - C2 * D$; where D is still-water depth. If blank default values of C1 = 0.03777 and C2 = 0.000667 are assumed.
	ICONV		ICONV = 1 (1 in card col. 80)
3		3F10.5, E10.4, 3F10.5, 2F5.1	
	T		forcing period (hours)
	DELT		approximate time increment
	AO		forcing wave amplitude (feet)
	AB		bay area at datum (square feet)
	BETA		bay area variation parameter
	ZETA		inlet side slope $D(z)/D(y)$
	QINFLO		bay inflow from sources other than the inlet (cubic feet per second)
	CDF		an empirical flood-loss coefficient
	CDE		an empirical ebb-loss coefficient
4		2I10, F10.0	
	IC		number of channels
	IS		number of cross sections
	QINT		estimated inlet discharge at the time the model starts
5	(one card per section)	10X, 7F10.5	
	A'		cell cross-sectional areas at the ends of each cell at datum (square feet) (see Fig. A-2)
6	(one card per section)	10X, 7F10.5	
	B'		grid cell widths for the end of each cell (feet) (see Fig. A-2)

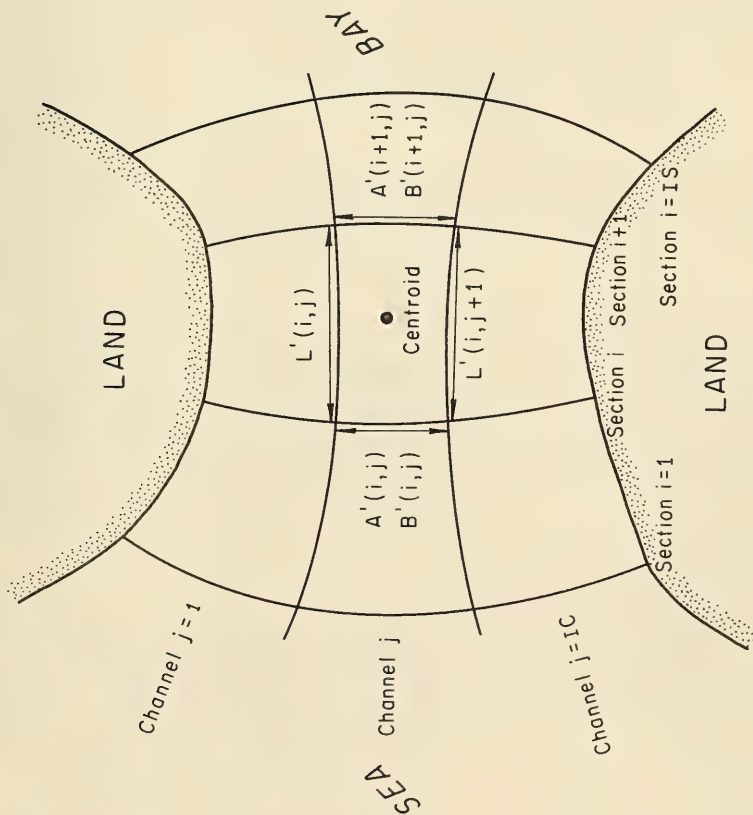


Figure A-2. Cell input data.

Cell characteristics

$$A(i, j) = \frac{A'(i, j) + A'(i+1, j)}{2}$$

$$B(i, j) = \frac{B'(i, j) + B'(i+1, j)}{2}$$

$$D(i, j) = A(i, j) / B(i, j)$$

$$L(i, j) = \frac{L'(i, j) + L'(i, j+1)}{2}$$

are applied at the cell centroid

Card type	Variables	Format	Description
7	(one less card than sections) L'	10X, 7F10.5	lengths of the sides of cells (see Fig. A-2) (one less card than number of sections; one more value per card than the number of channels)

For card types 5 to 7, there will be one card for each cross section of the inlet. The first card will be for the first cross section, i.e., the section closest to the sea, and the last section is adjacent to the bay. The first value on each card will correspond to the first channel adjacent to land; the last value on each card will correspond to the last channel also adjacent to land (Fig. A-2).

For more than one inlet connecting the bay to the sea, repeat card types 3 to 7 for each additional inlet.

Card type	Variables	Format	Description
8	TDEL NPTS	34X, F6.2 6X, I3	water level sampling interval (minute) number of sample points = 0 for no data
9	(optional--no cards if NPTS = 0 from card type 8) Y		eight water level values per card, as many cards to include NPTS points; start the model at a time when the sea level is zero. Use 25 or more points per forcing cycle for best results; i.e., levels at 30- or 15-minute intervals for a 12-hour tide.
10	(optional--two plot cards, first card used only if IPLOT = 1 on card type 1) XO XF SCALX YLO YL YLSCAL	8F10.5,/,3F10.5, I10	starting time of plot (hours) ending time of plot (hours) time scale (hours per inch) minimum value of water levels (feet) overall height of plot (inches) scale of water level height (feet per inch)

Card type	Variables	Format	Description
	YRO		minimum flows (thousand cubic feet per second)
	YRSCAL		scale of flows (thousand cubic feet per second per inch)

Second card

- | | | |
|--|--------|--|
| | YVO | minimum velocity (feet per second) |
| | YVSCAL | scale of velocities (feet per second per inch) |
| | SCALE | scale factor for total plot size |
| | IQ | IQ = 0 for no plot of inlet discharge |
- 11 If a plot is requested, repeat card types 8 and 9 for observed bay levels to compare with predictions (card type 8 required; use NPST = 0 for no observed bay levels). Only one set of card types 10 and 11 will be required for plotting even though the system modeled may have more than one inlet.
- 12 End of file card.

The inlet data for a computer run of Masonboro Inlet, North Carolina, are shown in Figure A-3.

3. Program Output.

The types of output include: (a) A summary table of grid dimensions, input parameters, and the Helmholtz period of the system estimated assuming there is no friction in the inlet; (b) (optional) summary tables of instantaneous inlet hydraulics; (c) (optional) a pen plot of inlet hydraulics; and (d) a table summarizing critical points throughout model operation, such as high water, low water, point of maximum discharge, and maximum velocity. Samples of input and output for the Masonboro Inlet run are given in Figures A-4, A-5, and A-6.

4. Computer Program.

A listing of the computer program (INLET) follows the sample output. The program was written in FORTRAN IV for a CDC 6600 computer with plotter. Control cards, plotting instructions, and file controls may have to be changed for other computers. If no plotter is available, the subroutine GRPHC and the call to the subroutine in the main program may be removed.


```

MASONBORO 1069
CDF=2.
      1      1      1      2      1      0.      0.      1
25.0      200.      2.15      20000F+09      0.2      0.0133      0.      2.      0.
      4      7      20000.
A1      24200.      5510.      4570.      2420.
A2      0725.      7885.      5880.      2140.
A3      1060.      5450.      5625.      3700.
A4      040.      2525.      1000.      5285.
A5      500.      1030.      5070.      4080.
A6      1770.      5860.      5330.      3925.
A7      4790.      6110.      6400.      4000.
B1      1000.      680.      200.      90.
B2      1320.      1400.      310.      100.
B3      500.      1380.      280.      240.
B4      150.      430.      450.      500.
B5      280.      150.      280.      350.
B6      840.      890.      420.      480.
B7      040.      670.      470.      240.
L1      550.      900.      1000.      1000.      1000.
L2      750.      750.      1000.      1000.      1000.
L3      000.      550.      900.      1050.      1200.
L4      500.      700.      850.      900.      900.
L5      000.      800.      950.      600.      200.
L6      200.      2100.      2100.      3600.      3400.
GAGE# 9/12/69 MASONBORO DELT= 30. NUN= 50
=1.79      =1.60      =1.65      =1.60      =1.38      =0.98      =0.80      =0.08
0.34      0.82      1.29      1.70      2.08      2.33      2.48      2.50
2.41      2.22      1.91      1.50      1.      0.50      0.      =0.50
=0.98      =1.32      =1.55      =1.62      =1.60      =1.44      =1.03      =0.69
=0.20      0.36      0.93      1.40      1.74      2.10      2.31      2.49
2.48      2.29      1.97      1.56      1.16      0.6      0.1      =0.4
=0.9      =1.3      2.      =3.      6.      1.      =60.      20.
0.      22.      2.      1.      0      6.      1.      =60.      20.
=6.      2.      1.
NO BAY
EOR

```

Figure A-3. Sample of input data for a computer run of Masonboro Inlet, North Carolina.

 MASONBORO 1969
 TEST

CONTROL CARDS

1 1 0 2 1 0.00000 0.00000
 25.00000 200.00000 2.15000 2000E+09 .20000 .01330 0.00000 2.0 0.0

SUMMARY OF INLET GRID CHARACTERISTICS
 INLET NUMBER 1

8

SECTION 1

CHANNEL #	1	2	3	4
AREA(FT ²)	19002.5	6697.5	5125.0	2280.0
WIDTH(FT)	2160.0	1040.0	285.0	95.0
DEPTH(FT)	8.80	6.44	17.98	24.00
LEN(FT)	875.0	950.0	1000.0	1000.0
N	.0319	.0335	.0259	.0218

SECTION 2

CHANNEL #	1	2	3	4
AREA(FT ²)	6402.5	6767.5	5652.5	2920.0
WIDTH(FT)	910.0	1390.0	295.0	180.0
DEPTH(FT)	7.04	4.87	19.16	16.22
LEN(FT)	850.0	975.0	1000.0	1000.0
N	.0331	.0345	.0250	.0269

SECTION 3

CHANNEL #	1	2	3	4
AREA(FT ²)	2010.0	4067.5	7827.5	4492.5
WIDTH(FT)	425.0	905.0	365.0	400.0
DEPTH(FT)	4.73	4.52	21.45	11.23
LEN(FT)	495.0	725.0	975.0	1125.0
N	.0346	.0348	.0235	.0303

SECTION 4

CHANNEL #	1	2	3	4
AREA(FT ²)	720.0	2780.5	7554.5	4682.5
WIDTH(FT)	315.0	290.0	365.0	445.0
DEPTH(FT)	2.29	9.59	20.70	10.52
LEN(FT)	600.0	775.0	875.0	900.0
N	.0362	.0314	.0240	.0308

SECTION 5

CHANNEL #	1	2	3	4
AREA(FT ²)	2135.0	4443.0	5204.5	4002.5
WIDTH(FT)	500.0	520.0	350.0	405.0
DEPTH(FT)	3.81	8.54	14.87	9.88
LEN(FT)	600.0	875.0	775.0	400.0
N	.0352	.0321	.0279	.0312

SECTION 6

CHANNEL #	1	2	3	4
AREA(FT ²)	4080.0	6230.0	6885.0	3902.5
WIDTH(FT)	910.0	780.0	545.0	300.0
DEPTH(FT)	4.48	7.94	12.60	11.81
LEN(FT)	2350.0	2100.0	2850.0	3500.0
N	.0348	.0324	.0294	.0304

FORCING PERIOD= 25.00 HOURS

THELMA(APPROX)= 3.17 HOURS

TF/TH= 7.88

INLET LENGTH ADDED LENGTH

1 1422.5 1749.4

YDEL. MIN= 30.00 HPTS= 50

-1.39 -1.60 -1.65 -1.40 -1.38 -.98 -.40 -.08 .34 .82 1.29 1.70 2.08 2.33 2.48 2.50
 2.41 2.22 1.91 1.50 1.00 .50 .10 -.50 -.92 -1.32 -1.55 -1.62 -1.60 -1.44 -1.03 -.69
 -.30 -.36 .93 1.40 1.74 2.10 2.31 2.44 2.40 2.24 1.97 1.50 1.16 .60 .10 -.40
 -.90 -1.30

Figure A-4. Sample output from INLET (summary table for Masonboro Inlet input data).

```

-----
TIME, HOURS = 6.000 DELT, SEC = 400.00

INLET 1
SFL LEVEL+FT= 2.08
SAV LEVEL+FT= 1.23
DISCHARGE+CFS= .5481E+05
DAY AREA= .2493E+09 FT2

CHANNEL SECTION 1 2 3 4 5 6 7 FRICTION
1 FRIC .04 .06 .07 .42 .11 .31 .12
1 LEVEL 2.08 2.08 2.06 1.70 1.32 1.26
1 V(FPS) .12 .33 .04 2.14 .96 .53
1 Q(CFS) 2802. 2802. 2802. 2802. 2802. 2802.
1 HEIGHT .05 .05 .05 .05 .05 .05
1 FRIC .00 .00 .00 .10 .01 .01 .19
2 LEVEL 2.06 2.02 1.94 1.66 1.39 1.29
2 V(FPS) 1.01 .93 1.52 2.71 1.73 1.24
2 Q(CFS) 8993. 8993. 8993. 8993. 8993. 8993.
2 HEIGHT .16 .16 .16 .16 .16 .16
2 FRIC .01 .01 .02 .10 .02 .03 .46
3 LEVEL 2.06 2.00 1.95 1.83 1.67 1.42
3 V(FPS) 5.40 4.94 3.63 3.77 5.35 4.07
3 Q(CFS) 31238. 31238. 11238. 31238. 31238. 31238.
3 HEIGHT .57 .57 .57 .57 .57 .57
3 FRIC .03 .03 .02 .11 .07 .20 .23
4 LEVEL 2.07 2.04 1.98 1.75 1.54 1.37
4 V(FPS) 4.60 3.50 2.20 2.13 2.52 2.62
4 Q(CFS) 11772. 11772. 11772. 11772. 11772. 11772.
4 HEIGHT .21 .21 .21 .21 .21 .21
4 FRIC .00 .01 .02 .10 .01 .08
TFMP ACC= .6 CONV ACC= 32.4 HEAD= -100.0 FRIC= 67.0
MEAN VELOCITY AT THE MINIMUM AREA SECTION= 2.97 FT/SEC AMTN= 18.29.73 FT2
-----

```

Figure A-5. Sample output from INLET (summary table of instantaneous hydraulics for Masonboro after 6 hours of model time).

SUMMARY TABLE OF HYDRAULICS INLET 1					
TIME	HS	INFLOW	HH	VEL	Q
HMS	FT	KCFS	FT	FPS	KCFS
.334	-1.506	0.000	-.239	-3.861*	-55.166*
1.056	-1.650*	0.000	-.451	-2.919	-39.568
2.167	-1.703	0.000	-1.562*	.053	.683
3.834	.155	0.000	-.541	2.463*	37.947
3.945	.245	0.000	-.456	2.491*	38.631
5.167	1.186	0.000	.516	2.922*	50.286
5.389	1.568	0.000	.698	2.940*	51.646
5.508	1.656	0.000	.788	2.945*	52.193
5.611	1.744	0.000	.878	2.948*	52.656
5.723	1.834	0.000	.967	2.957*	53.252
5.834	1.922	0.000	1.056	2.968*	53.884
5.945	2.005	0.000	1.145	2.976*	54.441
6.056	2.088	0.000	1.234	2.974*	54.806
6.167	2.145	0.000	1.321	2.958*	54.889*
7.389	2.506*	0.000	2.147	2.154	41.977
8.389	2.295	0.000	2.462*	.086	1.714
10.611	.444	0.000	1.191	-3.308	-55.734*
10.667	.389	0.000	1.146	-3.337*	-55.713
10.778	.278	0.000	1.055	-3.362*	-55.607
10.889	.166	0.000	.962	-3.382*	-55.425
11.000	.055	0.000	.869	-3.398*	-55.177
11.111	-.056	0.000	.774	-3.411*	-54.870
11.223	-.168	0.000	.679	-3.422*	-54.519
11.334	-.279	0.000	.582	-3.429*	-54.126
11.445	-.391	0.000	.485	-3.433*	-53.680
11.556	-.500	0.000	.387	-3.433*	-53.170
11.667	-.611	0.000	.288	-3.430*	-52.606
11.778	-.723	0.000	.188	-3.427*	-52.037
11.889	-.831	0.000	.087	-3.420*	-51.412
12.000	-.933	0.000	-.014	-3.403*	-50.657
13.723	-1.625*	0.000	-1.618	-1.764	-22.758
14.445	-1.495	0.000	-1.665*	-.073	-.923
15.389	-.812	0.000	-1.245	1.880*	25.949
17.278	1.153	0.000	.185	2.994*	50.979
17.389	1.257	0.000	.283	3.020*	52.006
17.500	1.354	0.000	.382	3.036*	52.865
17.667	1.484	0.000	.526	3.089*	53.680*
17.778	1.659	0.000	.625	3.002*	53.685
17.834	1.695	0.000	.672	3.004	53.720*
17.889	1.630	0.000	.719	3.033*	53.719
18.056	1.740	0.000	.858	2.994	53.442*
18.111	1.780	0.000	.904	2.973*	53.468
18.223	1.864	0.000	.994	2.965*	53.749
18.334	1.949	0.000	1.083	2.967*	54.204
18.445	2.030	0.000	1.172	2.969*	54.648
18.556	2.100	0.000	1.260	2.962	54.883*
19.778	2.508*	0.000	2.099	2.267	44.163
20.723	2.196	0.000	2.416*	-.016	-.312
21.778	1.390	0.000	1.904	-2.904*	-52.620*
21.889	1.305	0.000	1.827	-2.921*	-52.545
22.000	1.211	0.000	1.750	-2.942	-52.477*
22.778	.373	0.000	1.157	-3.394*	-56.639*
22.889	.264	0.000	1.064	-3.415*	-56.478
23.000	.155	0.000	.970	-3.429*	-56.184
23.111	.044	0.000	.876	-3.440*	-55.836
23.223	-.067	0.000	.780	-3.449*	-55.460
23.334	-.178	0.000	.684	-3.456*	-55.044
23.445	-.289	0.000	.587	-3.459*	-54.588
23.556	-.400	0.000	.489	-3.461*	-54.092
23.667	-.513	0.000	.390	-3.461*	-53.574
23.778	-.628	0.000	.290	-3.463*	-53.063
23.889	-.741	0.000	.189	-3.462*	-52.518
24.000	-.849	0.000	.087	-3.454*	-51.870
24.111	-.951	0.000	-.015	-3.435*	-51.063
24.223	-1.052	0.000	-.117	-3.409*	-50.167
25.000	-1.390*	0.000	-.855	-2.599	-35.948

* CRITICAL POINT VALUE

Figure A-6. Sample output from INLET (table of critical points for the model time: high water, low water, etc., for Masonboro Inlet).

Listing of the computer program INLET.

```

      PROGRAM INLET(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE9,TAPE10, INLET      2
      1 TAPE3,PUNCHED=TAPE3) INLET      3
C  PROGRAM NUMBER 720X6R1850 (INLET) ANALYSES AND PREDICTS INSTANTANEOUS INL INLET      4
C  HYDRAULICS USING A LUMPED PARAMETER SCHEME (SEE SFELIG, HARRIS AND INLET      5
C  MECHANISMS; 1976, I.A. GENERALIZED LUMPED PARAMETER MODEL OF INLET INLET      6
C  HYDRAULICS, A DRAFT CERC REPORT) INLET      7
      REAL L,LENGTH,LIN,LY,N,NX INLET      8
      COMMON/NUMS/NL,N,NINLET,ICH(3),ISE(3),OR,L(7,7),B(7,7),D(7,7), INLET      9
      1 A(7,7),N(7,7),W(7,7),V(7,7),Q(7,7),MS,HB,H(7,7),IC,IS,AMINI(3), INLET     10
      1BMINI(3),LT,N,OX(3),OINFLD,ARRAY,LENGTH(3) INLET     11
      COMMON/NUM1/Y(5),DERV(5),X,NT,IWT,ZETA,HH INLET     12
      COMMON/NUM2/BX(3,7,7),DX(3,7,7),HX(3,7,7),WX(3,7,7),LX(3,7,7),NX(3 INLET     13
      1,7,7) INLET     14
      COMMON /NUM3/AO,T,AR,RETA INLET     15
      COMMON/NUM4/RNK(3,4) INLET     16
      DIMENSION CORL(3) INLET     17
      DIMENSION ALABL1(4),ALABL2(4),IBUF(1000),NUMBER(20) INLET     18
3370 CONTINUE INLET     19
      DO 2193 I=1,3 INLET     20
2193 OX(I)=1. INLET     21
C  G= ACCELERATION OF GRAVITY INLET     22
      G=32.2 INLET     23
      DO 1211 I=1,20 INLET     24
1211 NUMBER(I)=1 INLET     25
      WRITE(6,2937) INLET     26
2937 FORMAT(/,1X, '-----') INLET     27
      READ(5,1167) (ALABL1(I),I=1,4) INLET     28
      READ(5,1167) (ALABL2(I),I=1,4) INLET     29
1167 FORMAT(4A10) INLET     30
      WRITE(6,1168) (ALABL1(I),I=1,4) INLET     31
      WRITE(6,1168) (ALABL2(I),I=1,4) INLET     32
1168 FORMAT(4X,4A10) INLET     33
      WRITE(6,1268) INLET     34
1268 FORMAT(/,5X, 'CONTROL CARDS() INLET     35
C  READ CONTROL CARDS INLET     36
C INLET     37
      READ(5,1011) NINLET,NCYCLES,IPL0T,IWT,ITABLE,C1,C2 INLET     38
      WRITE(6,1012) NINLET,NCYCLES,IPL0T,IWT,ITABLE,C1,C2 INLET     39
1011 FORMAT(5I10,2F10,5) INLET     40
1012 FORMAT(1X,5I10,2F10,5) INLET     41
C  NINLET=THE NUMBER OF INLETS INLET     42
C  NCYCLES= NUMBER OF TIDAL CYCLES INLET     43
C  IPL0T (1 FOR A PLOT OF MEAN HYDRAULICS, 0 FOR NO PLOT) INLET     44
C  IWT IS A PARAMETER DESCRIBING THE TYPE OF W/FIGHTING DESIRED INLET     45
C  IWT=1 FOR FLOW HEIGHTING TO ACHIEVE MINIMUM FRICTION INLET     46
C  IWT=2 FOR WEIGHTING FOR MINIMUM FRICTION WITH NO FLOW ACROSS CHANNELS INLET     47
C  IWT=3 FOR EQUAL FLOW IN ALL GRIDS TO GIVE MAXIMUM FRICTION INLET     48
C  ITABLE=1 FOR A TABLE OF OUTPUT INLET     49
C  C1=C2=NC1-C2 * D. IF C1 AND C2 ARE ZERO THE MASCH VALUES OF INLET     50
C  C1 =.03777 AND C2=.000667 ARE USED INLET     51
      IF(C1.EQ.0.0,AND,C2.EQ.0.0) C2= 0.000667 INLET     52
      IF(C1.EQ.0.0,) C1=.03777 INLET     53
C INLET     54

```


1	FORMAT(AI10)	INLET	55
	READ(5,111) T,DFLT,AO,AM,BETA,ZETA,QINFLO	INLET	56
	WRITE(6,111) T,DELTA,AB,BETA,ZETA,QINFLO	INLET	57
111	FORMAT(3F10.5,4E10.4,4F10.5)	INLET	58
C	T=TIDAL PERIOD, HRS (LATER CONVERTED TO SECONDS)	INLET	59
C	DELTA=ESTIMATED TIME STEP, SEC	INLET	60
C	AM=SEA TIDAL AMPLITUDE, FT	INLET	61
C	AB=RAY AREA AT THE DATUM, SQUARE FEET	INLET	62
C	BETA=RAY AREA VARIATION PARAMETER (D(AB)/D(HB))	INLET	63
C	ZETA=CHANNEL SLOPE (D(Y)/D(X))	INLET	64
C	QINFLO=INFLOW INTO THE BAY FROM OTHER SOURCES (FT ³ /SEC)	INLET	65
C		INLET	66
	ENDUT=NCYCLES*3600.	INLET	67
	IF(ZETA.LE.0.)ZETA=1.E25	INLET	68
	NT=N	INLET	69
C		INLET	70
C	READ IN INFORMATION OF EACH INLET	INLET	71
	DO 110 NI=1,NINLET	INLET	72
	IUNITF=NI	INLET	73
	RE=IND UNIT	INLET	74
	READ(5,1) IC,IS	INLET	75
C	IC=NUMBER OF CHANNELS	INLET	76
C	IS=NUMBER OF INLET CROSS-SECTIONS	INLET	77
	IF(IC.GT.7.OR.IS.GT.7) WRITE(6,1671)	INLET	78
1671	FORMAT(///,5X,('**** TOO MANY GRIDS FOR DIMENSIONS',//))	INLET	79
	IC*(NI)=IC	INLET	80
C	READ SECTION AREAS (ONE CARD PER SECTION)	INLET	81
	DO 5 I=1,IS	INLET	82
5	READ(5,2) (A(I,J),J=1,IC)	INLET	83
2	FORMAT(10X,7F10.5)	INLET	84
C		INLET	85
C	READ SECTION WIDTHS (ONE CARD PER SECTION)	INLET	86
	DO 6 I=1,IS	INLET	87
6	READ(5,2) (H(I,J),J=1,IC)	INLET	88
C		INLET	89
	ICPI=IC+1	INLET	90
	ISPI=IS+1	INLET	91
C	READ LENGTHS (ONE MORE LENGTH PER CARD THAN CHANNELS)	INLET	92
C	(ONE LESS CARD THAN THE NUMBER OF SECTIONS)	INLET	93
	DO 7 I=1,ISPI	INLET	94
7	READ(5,2) (L(I,J),J=1,ICPI)	INLET	95
C		INLET	96
C	INITIALIZE VARIABLES TO BEGIN ITERATION	INLET	97
C	NUMBER OF GRIDS ALONG THE CHANNEL IS ONE LESS THAN THE NUMBER OF	INLET	98
C	CROSS-SECTIONS	INLET	99
88	IS=IS-1	INLET	100
	ISE(NI)=IS	INLET	101
	ISPI=IS-1	INLET	102
	WRITE(6,3678) NI	INLET	103
3678	FORMAT(//,5X,('SUMMARY OF INLET GRID CHARACTERISTICS',//	INLET	104
1	15X,('INLET NUMBER',I3)	INLET	105
	WRITE(6,1) IC,IS	INLET	106
	DO 10 I=1,IS	INLET	107

DO 11 J=1,IC	INLET	108
LENGTH(NI)=LENGTH(NT)+L(I,J)/FLOAT(IC)	INLET	109
A(I,J)=(A(I,J)+A(I+1,J))/2.	INLET	110
L(I,J)=(L(I,J)+L(I+1,J))/2.	INLET	111
H(I,J)=(H(I,J)+H(I+1,J))/2.	INLET	112
D(I,J)=A(I,J)/H(I,J)	INLET	113
N(I,J)=C1-C2*D(I,J)	INLET	114
LX(NI+1,J)=L(I,J)	INLET	115
HX(NI+1,J)=H(I,J)	INLET	116
DX(NI+1,J)=D(I,J)	INLET	117
NX(NI+1,J)=N(I,J)	INLET	118
AX(NI+1,J)=1./FLOAT(IC)	INLET	119
11 CONTINUE	INLET	120
WRITE(6,1297) I	INLET	121
1297 FORMAT(/,1X,(SECTION(I),13)	INLET	122
WRITE(6,1221) (NUMBER(I),I=1,IC)	INLET	123
1221 FORMAT(5X,(CHANNEL=(,10110,/)	INLET	124
C PRINT A SUMMARY TABLE OF GEOMETRIES	INLET	125
WRITE(6,1971) (A(I,J),J=1,IC)	INLET	126
WRITE(6,1972) (H(I,J),J=1,IC)	INLET	127
WRITE(6,1973) (N(I,J),J=1,IC)	INLET	128
WRITE(6,1974) (L(I,J),J=1,IC)	INLET	129
WRITE(6,1975) (NX(I,J),J=1,IC)	INLET	130
1971 FORMAT(5X,(AREA(F2),10F10.1)	INLET	131
1972 FORMAT(5X,(WIDTH(FT),10F10.1)	INLET	132
1973 FORMAT(5X,(DEPTH(FT),1X,10F10.2)	INLET	133
1974 FORMAT(5X,(LEN(FT),2X,10F10.1)	INLET	134
1975 FORMAT(5X,(NI,10X,10F10.4)	INLET	135
10 CONTINUE	INLET	136
C FIND AREA AND WIDTH AT THE MINIMUM SECTION	INLET	137
AMINI(NI)=99.E+12	INLET	138
DO 109 I=1,18	INLET	139
AA=0.	INLET	140
BB=0.	INLET	141
DO 108 J=1,IC	INLET	142
AA=AA+A(I,J)	INLET	143
108 HH=HH+H(I,J)	INLET	144
IF(AA.GT.AMINI(NI)) GO TO 109	INLET	145
AMINI(NI)=AA	INLET	146
BMINI(NI)=HH	INLET	147
109 CONTINUE	INLET	148
1110 CONTINUE	INLET	149
C ESTIMATE THE INLET=RAY HELMHOLTZ PERIOD	INLET	150
CALL HELM(THELM,HH,CORL)	INLET	151
THTF=T/THELM	INLET	152
WRITE(6,201) T,THELM,THTF	INLET	153
201 FORMAT(1X,(FORCING PERIOD=1,F7.2,(HOURS(,	INLET	154
1/,1X,(THELM(APPROX)=1,F8.2,(HOURS(,	INLET	155
1 1X,(TF/T=1,10X,F6.2)	INLET	156
WRITE(6,1337) ((J,LFNGTH(J),CORL(J)),J=1,NINLET)	INLET	157
1337 FORMAT(1X,INLET LENGTH ADDED LENGTH1, (/ ,4X,I2,1X,	INLET	158
1 F6.1,2X,F6.1))	INLET	159
T=3600.	INLET	160
CALL RKGS(END,DELT,NINLET,QINFLO,ITABLE,T)	INLET	161
DELT=END/FLOAT(NT)	INLET	162
DO 2269 NI=1,NINLET	INLET	163
HH=HS	INLET	164
WRITE(6,2268) NI	INLET	165
2268 FORMAT(/,10X,(SUMMARY TABLE OF HYDRAULICS INLET(I,15)	INLET	166
1UNTUNIT=AA	INLET	167
CALL CRIT(NT,DELT,IUNIT,T,NCYCLES)	INLET	168
IF(TPLOT,EQ,1,AND,NT,EQ,1) CALL PLOTS(1RUF,1000,3)	INLET	169
IF(TPLOT,EQ,1) CALL GRPMC(ALAHL1,ALAHL2,DELT,IUNIT,NI)	INLET	170
IF(TPLOT,EQ,1,AND,NI,EQ,NINLET) CALL PLOT(0,0,0,999)	INLET	171
2269 CONTINUE	INLET	172
STOP	INLET	173
END	INLET	174

SUBROUTINE RKGS(END,DFLT,NINLET,DINFLO,ITABLE,T)	INLET	175
C ROUTINE TO SOLVE A SET OF SIMULTANEOUS DIFFERENTIAL EQUATIONS	INLET	176
C ADAPTED FROM SCIENTIFIC SUBROUTINE PACKAGE, IRM, 1970	INLET	177
COMMON/NUM1/Y(5),DERY(5),X,NT,IMT,ZETA,HS	INLET	178
COMMON/NUM4/RNKK(3+4)	INLET	179
DIMENSION AUX(8+5),A(8)+B(8)+C(8)+PRMT(5)+AMINI(3)	INLET	180
NDIM=NINLET+1	INLET	181
PRMT(1) = 1.	INLET	182
PRMT(2)=END	INLET	183
PRMT(3)=DELT	INLET	184
PRMT(4) = ,1	INLET	185
IF(T.GT,36000.) DELTH=3600.	INLET	186
IF(T.LE,36000.) DFLTH=T/9.	INLET	187
DO 1122 JN=1,NINLET	INLET	188
Y(JN)=0,01	INLET	189
1122 DERY(JN)=0,001	INLET	190
Y(NDIM)=0.	INLET	191
DERY(NDIM)=1,0=FLOAT(NINLET)*0,001	INLET	192
DO 1 I=1,NDIM	INLET	193
1 AUX(8+I)=0,066666667*DERY(I)	INLET	194
X=PRMT(1)	INLET	195
XEND=PRMT(2)	INLET	196
H=PRMT(3)	INLET	197
PRMT(5)=0.	INLET	198
CALL SETEG(AMINI)	INLET	199
IF(H*(XEND-X))3R,37,2	INLET	200
2 CONTINUE	INLET	201
A(1)=0,5	INLET	202
A(2)=0,2928932	INLET	203
A(3)=1,707107	INLET	204
A(4)=0,16666667	INLET	205
B(1)=2.	INLET	206
B(2)=1.	INLET	207
B(3)=1.	INLET	208
B(4)=2.	INLET	209
C(1)=0,5	INLET	210
C(2)=0,2928932	INLET	211
C(3)=1,707107	INLET	212
C(4)=0,5	INLET	213
DO 3 I=1,NDIM	INLET	214
AUX(1+I)=Y(I)	INLET	215
AUX(2+I)=DERY(I)	INLET	216
AUX(3+I)=0.	INLET	217
3 AUX(6+I)=0.	INLET	218
IREC=0	INLET	219
H=H+H	INLET	220
IMLF=1	INLET	221
ISTEP=0	INLET	222
IFEND=0	INLET	223
4 CONTINUE	INLET	224
IF((X+XEND)*H)7,6,5	INLET	225
5 CONTINUE	INLET	226
6 CONTINUE	INLET	227

M=XFND=X	INLET	228
IEND=1	INLET	229
7 CONTINUE	INLET	230
CALL SEA(HS,X)	INLET	231
CALL TPRWTE(NINLET,X,HS,QINFLO,Y,AMINI,RNK,NT)	INLET	232
IFLAG1=X/DELT8	INLET	233
IF(FLAG1.NE.IFLAG2.AND.1TABLE.EQ.1) CALL TABLE	INLET	234
IFLAG2=1FLAG1	INLET	235
IF(PRINT(5))40,8,40	INLET	236
8 CONTINUE	INLET	237
ITEST=0	INLET	238
9 CONTINUE	INLET	239
ISTEP=ISTEP+1	INLET	240
J=1	INLET	241
10 CONTINUE	INLET	242
AJ=A(J)	INLET	243
HJ=H(J)	INLET	244
CJ=C(J)	INLET	245
DO 11 I=1,NDIM	INLET	246
H1=H*DERV(I)	INLET	247
R2=AJ*(R1+HJ*AUX(6,I))	INLET	248
Y(I)=Y(I)+R2	INLET	249
R2=R2+HJ+H2	INLET	250
11 AUX(6,I)=AUX(6,I)+R2+CJ*R1	INLET	251
IF(J=4)12,15,15	INLET	252
12 CONTINUE	INLET	253
J=J+1	INLET	254
IF(J=3)13,14,13	INLET	255
13 CONTINUE	INLET	256
X=X+0.5*H	INLET	257
14 CONTINUE	INLET	258
CALL SETEQ(AMINT)	INLET	259
GO TO 10	INLET	260
15 CONTINUE	INLET	261
IF(ITEST)16,16,20	INLET	262
16 CONTINUE	INLET	263
DO 17 I=1,NDIM	INLET	264
17 AUX(4,I)=Y(I)	INLET	265
ITEST=1	INLET	266
ISTEP=ISTEP+ISTEP=2	INLET	267
18 CONTINUE	INLET	268
IHLF=IHLF+1	INLET	269
X=X-H	INLET	270
H=0.5*H	INLET	271
DO 19 I=1,NDIM	INLET	272
Y(I)=AUX(1,I)	INLET	273
DERV(I)=AUX(2,I)	INLET	274
19 AUX(6,I)=AUX(3,I)	INLET	275
GO TO 9	INLET	276
20 CONTINUE	INLET	277
IPUD=ISTEP/2	INLET	278
IF(ISTEP=IMOD=IMOD)21,23,21	INLET	279
21 CONTINUE	INLET	280

	CALL SETEQ(AMINT)	INLET	281
	DO 22 I=1,NDIM	INLET	282
	AUX(5,I)=Y(I)	INLET	283
22	AUX(7,I)=DERV(I)	INLET	284
	GO TO 9	INLET	285
23	CONTINUE	INLET	286
	DELT=0.	INLET	287
	DO 24 I=1,NDIM	INLET	288
24	DELT=DELT+AUX(8,I)*ABS(AUX(4,I)-Y(I))	INLET	289
	IF(DELT=PRMT(4))28,28+25	INLET	290
25	CONTINUE	INLET	291
	IF(IHLF=10)26,36+36	INLET	292
26	CONTINUE	INLET	293
	DO 27 I=1,NDIM	INLET	294
27	AUX(4,I)=AUX(5,I)	INLET	295
	ISTEP=ISTEP+ISTEP/4	INLET	296
	X=X+H	INLET	297
	IEND=0	INLET	298
	GO TO 18	INLET	299
28	CONTINUE	INLET	300
	CALL SETEQ(AMINT)	INLET	301
	DO 29 I=1,NDIM	INLET	302
	AUX(1,I)=Y(I)	INLET	303
	AUX(2,I)=DERV(I)	INLET	304
	AUX(3,I)=AUX(6,I)	INLET	305
	Y(I)=AUX(5,I)	INLET	306
29	DERV(I)=AUX(7,I)	INLET	307
	CALL SEACHS(X=H)	INLET	308
	CALL TPRWTE(NINLET,X=H,HS,QINFLO,Y,AMINT,RNK,NT)	INLET	309
	IFLAG1=(X=H)/DELT8	INLET	310
	IF(TFLAG1.NF,IFLAG2.AND,ITABLE,EQ,1) CALL TABLE	INLET	311
	IFLAG2=IFLAG1	INLET	312
	IF(PRMT(5))40,30+40	INLET	313
30	CONTINUE	INLET	314
	DO 31 I=1,NDIM	INLET	315
	Y(I)=AUX(1,I)	INLET	316
31	DERV(I)=AUX(2,I)	INLET	317
	IHLF=IHLF	INLET	318
	IF(IEND)32,32+39	INLET	319
32	CONTINUE	INLET	320
	IHLF=IHLF+1	INLET	321
	ISTEP=ISTEP/2	INLET	322
	H=H+H	INLET	323
	IF(IHLF)4,33+33	INLET	324
33	CONTINUE	INLET	325
	IMOD=ISTEP/2	INLET	326
	IF(ISTEP=IMOD=IMOD)4,34+4	INLET	327
34	CONTINUE	INLET	328
	IF(DELT=0.02*PRMT(4))35,35+4	INLET	329
35	CONTINUE	INLET	330
	IHLF=IHLF+1	INLET	331
	ISTEP=ISTEP/2	INLET	332
	H=H+H	INLET	333
	GO TO 4	INLET	334
36	CONTINUE	INLET	335
	IHLF=11	INLET	336
	CALL SETEQ(AMINT)	INLET	337
	GO TO 39	INLET	338
37	CONTINUE	INLET	339
	IHLF=12	INLET	340
	GO TO 39	INLET	341
38	CONTINUE	INLET	342
	IHLF=13	INLET	343
39	CONTINUE	INLET	344
	CALL SEACHS(X)	INLET	345
	CALL TPRWTE(NINLET,X=H,HS,QINFLO,Y,AMINT,RNK,NT)	INLET	346
	IFLAG1=X/DELT8	INLET	347
	IF(TFLAG1.NF,IFLAG2.AND,ITABLE,EQ,1) CALL TABLE	INLET	348
	IFLAG2=IFLAG1	INLET	349
40	CONTINUE	INLET	350
	RETURN	INLET	351
	END	INLET	352

	SUBROUTINE SETEQ(AMIN)	INLET	353
C	ROUTINE TO SETUP THE EQUATIONS FOR THE RIGHT HAND SIDE OF THE EQUATIONS	INLET	354
C	MOTION AND TO DETERMINE THE RANK OF THE TERMS IN THE EQUATION OF MOTIO	INLET	355
	REAL L,LENGTH,LIN,LX,N,NX,LF	INLET	356
	COMMON/NUM5/N1,G,NINLET,ICH(3),ISE(3),GR,L(7,7),B(7,7),D(7,7),	INLET	357
	1 A(7,7),N(7,7),W(7,7),V(7,7),Q(7,7),HS,HB,H(7,7),IC,IS,AMIN(3),	INLET	358
	1HMNI(3),LIN,QX(3),QINFLO,ARRAY,LENGTH(3)	INLET	359
	COMMON/NUM1/Y(5),DERV(5),X,NT,IWT,ZETA,HH	INLET	360
	COMMON/NUM2/BX(3,7,7),DX(3,7,7),HX(3,7,7),WX(3,7,7),LX(3,7,7),NX(3	INLET	361
	1,7,7)	INLET	362
	COMMON /NUM3/A0,T,ARY,BETA	INLET	363
	COMMON/NUM4/RNK(3+4)	INLET	364
	DIMENSION AMIN(3)	INLET	365
	G=32,2	INLET	366
	DO 220 NI=1,3	INLET	367
	DO 119 I=1,4	INLET	368
119	RNK(NI,I)=0,	INLET	369
220	CONTINUE	INLET	370
	CALL SEA(HS,X)	INLET	371
	HH=HS	INLET	372
C	FIND THE BAY AREA	INLET	373
	HRZY(NINLET+1)	INLET	374
	ARZY=ARZY*(1+BETA*HR)	INLET	375
	QT=0,	INLET	376
C	SET UP EQUATIONS FOR EACH INLET	INLET	377
	DO 100 NI=1,NINLET	INLET	378
	AMIN(NI)=9999999999,	INLET	379
	QD=V(NI)	INLET	380
	QT=QT+QD	INLET	381
	IC=ICH(NI)	INLET	382
	IS=ISE(NI)	INLET	383
	LF=0,	INLET	384
	DO 95 I=1,IS	INLET	385
	DO 94 J=1,IC	INLET	386
	N(I,J)=HX(NI,I,J)	INLET	387
	L(I,J)=LX(NI,I,J)	INLET	388
	LF=LF+L(I,J)/(FLOAT(IC))	INLET	389
94	H(I,J)=HX(NI,I,J)	INLET	390
95	CONTINUE	INLET	391
	CALL LEVEL	INLET	392
	AS=0,	INLET	393
	AM=0,	INLET	394
	AF=0,	INLET	395
	DO 97 I=1,IS	INLET	396
	AA=0,	INLET	397
	DL=0,	INLET	398
	DO 96 J=1,IC	INLET	399
	DL=DL+L(I,J)/(FLOAT(IC)*LE)	INLET	400
	D(I,J)=DX(NI,I,J)+H(I,J)	INLET	401
	IF(D(I,J).LT,0.) D(I,J)=0.,001	INLET	402
	A(I,J)=H(I,J)*D(I,J)+H(I,J)*ABS(H(I,J))/(ZETA*FLOAT(IC))	INLET	403
	IF(A(I,J).LT,0.) A(I,J)=0.,001	INLET	404
	IF(I,EQ,1) AS=AS+A(I,J)	INLET	405

	IF(T,EO,IS) AB=AB+A(I,J)	INLET	406
96	AA=AA+A(I,J)	INLET	407
	IF(AA,LT,AMIN(NI)) AMIN(NI)=AA	INLET	408
97	AE=AE+DL/AA	INLET	409
	AMIN(NI)=AMIN(NI)	INLET	410
	AE=1./AE	INLET	411
	IF(T=1,EU,1) CALL WT1	INLET	412
	IF(T=1,EU,2) CALL WT2	INLET	413
	IF(T=1,EU,3) CALL WT3	INLET	414
	DO 140 I=1,IS	INLET	415
	DO 139 J=1,IC	INLET	416
	WX(NI+I,J)=W(I,J)	INLET	417
139	WX(NI+I,J)=W(I,J)	INLET	418
140	CONTINUE	INLET	419
	RNK(NI+2)=AE/(2.*LE)*(1./(AR**2)+1./(AS**2))*QQ*QQ	INLET	420
	RNK(NI+3)=G*AE/LE*(HB=HS)	INLET	421
	DO 85 I=1,IS	INLET	422
	AC=0.	INLET	423
	DO 84 J=1,IC	INLET	424
84	AC=AC+A(I,J)	INLET	425
	DO 83 J=1,IC	INLET	426
83	RNK(NI+4)=RNK(NI+4)+AF/(LE*AC)*G*N(I,J)**2*ABS(W(I,J)*UQ)*	INLET	427
	1*(I,J)*UQ/(2.*20*W(I,J)**0.33333*A(I,J)**2)*L(I,J)*B(I,J)	INLET	428
85	CONTINUE	INLET	429
	RNK(NI+1)=RNK(NI+2)+RNK(NI+3)+RNK(NI+4)	INLET	430
	DERV(NI)=RNK(NI+1)	INLET	431
C	FIND THE RELATIVE RANK OF TERMS, NORMALIZE BY THE LARGEST TERM.	INLET	432
	XMAX=0.	INLET	433
	DO 101 I=1,4	INLET	434
101	IF(ABS(RNK(NI+I)).GT,XMAX) XMAX=ABS(RNK(NI+I))	INLET	435
	DO 102 I=1,4	INLET	436
102	RNK(NI+I)=100.*RNK(NI+I)/XMAX	INLET	437
100	CONTINUE	INLET	438
	DERV(NINLET+1)=DT/ARAY+QINFLO/ABAY	INLET	439
	RETURN	INLET	440
	END	INLET	441
	SUBROUTINE TPWRTE(NINLET,X,HS,QINFLO,Y,AMIN,RNK,NT)	INLET	442
C	SUBROUTINE TO WRITE HYDRAULIC INFORMATION ON TAPES	INLET	443
	DIMENSION RNK(3,4),V(5)=AMIN(3)	INLET	444
	HOURS=X/3600.	INLET	445
	NT=NT+1	INLET	446
	DO 100 NI=1,NINLET	INLET	447
	IUNIT=NI+8	INLET	448
	V=V(NI)+AMIN(NI)	INLET	449
100	WRITE(IUNIT) HOURS,HS,QINFLO,Y(NINLET+1),V,V(NI),(RNK(NI,J),J=1,4)	INLET	450
	RETURN	INLET	451
	END	INLET	452

	SUBROUTINE LEVEL	INLET	453
C	THIS ROUTINE COMPUTES WATER LEVELS THROUGHOUT THE INLET ASSUMING LEVEL	INLET	454
C	ARE LINFAR FROM RAY TO SEA	INLET	455
	REAL L,LENGTH,INLY,X,NX	INLET	456
	COMMON/NUMS/NI,G,NINLET,ICH(3),ISE(3),OR,L(7,7),B(7,7),D(7,7),	INLET	457
	1 A(7,7),N(7,7),W(7,7),V(7,7),O(7,7),HS,HB,H(7,7),IC,IS,AMINI(3),	INLET	458
	1BMINI(3),LIN,OX(3),QINFLO,ABAV,LENGTH(3)	INLET	459
	DO 20 J=1,IC	INLET	460
	XL=0.	INLET	461
	DO 10 I=1,IS	INLET	462
10	XL=XL+L(I,J)	INLET	463
	XX=L(1,J)/2.	INLET	464
	H(I,J)=HS+(HB=HS)/XL*XX	INLET	465
	DO 11 I=2,IS	INLET	466
	XX=(L(I=1,J)+L(I,J))/2+XX	INLET	467
11	H(I,J)=HS+(HB=HS)/XL*XX	INLET	468
20	CONTINUE	INLET	469
	RETURN	INLET	470
	END	INLET	471
	SUBROUTINE SEA(HS,TIME)	INLET	472
C	THIS SUBROUTINE DETERMINES THE FORCING SEA LEVEL EITHER FROM	INLET	473
C	EQUAL TIME SERIES DATA (IF AVAILABLE) OR BY SINUSODIAL FORCING.	INLET	474
	COMMON /NUM3/AO,T*AR,BETA	INLET	475
	DIMENSION Y(52)	INLET	476
	N=NIN+1	INLET	477
	IF(NIN.NE.1) GO TO 10	INLET	478
	READ(5,1) TDEL,NPTS	INLET	479
1	FORMAT(3X,F0.2,6X,I3)	INLET	480
	TDEL=TDEL*60.	INLET	481
C	READ SEA LEVEL EQUAL TIME SERIES DATA THE FIRST TIME SEA IS CALLED	INLET	482
C	IF NPTS IS GREATER THAN 1	INLET	483
	IF(NPTS.GT.1) READ(5,2) (Y(J),J=1,NPTS)	INLET	484
2	FORMAT(A10,5)	INLET	485
	IF(NPTS.GT.1) WRITE(6,3) (Y(J),J=1,NPTS)	INLET	486
3	FORMAT(3X,16F0.2)	INLET	487
	N1=NPTS+1	INLET	488
	N2=NPTS+2	INLET	489
	Y(N1)=Y(1)	INLET	490
	Y(N2)=Y(2)	INLET	491
10	IF(NPTS.LT.1) GO TO 100	INLET	492
C	INTERPOLATE IN TIME	INLET	493
	IT=TIME/T	INLET	494
	XT=TIME-IT*T	INLET	495
	J=XT/TDEL	INLET	496
	J=J+1	INLET	497
	HS=Y(J)+((Y(J+1)-Y(J))*(XT=(J-1)*TDEL)/TDEL)	INLET	498
	RETURN	INLET	499
C	DETERMINE LEVEL IF SEA LEVEL FLUCTUATION IS SINUSODIAL	INLET	500
100	HS=AO* SIN(2.*3.14158*TIME/T)	INLET	501
	RETURN	INLET	502
	END	INLET	503

SUBROUTINE HELM(THELM,AB,CORL)	INLET	504
C ESTIMATE THE INLET=RAY HELMHOLTZ PERIOD	INLET	505
C OF THE INLET/RAY SYSTEM (NEGLECT FRICTION)	INLET	506
REAL L,LENGTH,LTN,LX,N,NX	INLET	507
COMMON/NUMS/NI,G,NINLET,ICH(3),ISE(3),QR,L(7,7),B(7,7),D(7,7),	INLET	508
1 A(7,7),N(7,7),H(7,7),V(7,7),Q(7,7),HS,HB,H(7,7),IC,IS,AMINI(3),	INLET	509
IRMINI(3),LIN,QX(3),QINFLO,ABAY,LENGTH(3)	INLET	510
DIMENSION CORL(3)	INLET	511
C USE FIVE ITERATIONS TO OBTAIN THE ESTIMATE	INLET	512
DO 1000 I=1,5	INLET	513
SUM=0.	INLET	514
DO 100 NN=1,NINLET	INLET	515
AMIN=AMINI(NN)	INLET	516
100 SUM=SUM+AMIN/(LENGTH(NN)+CORL(NN))	INLET	517
THELM=2.*3.14159* SQRT(AB/G)/ SQRT(SUM)	INLET	518
C ESTIMATE THE HELMHOLTZ PERIOD	INLET	519
DO 101 NN=1,NINLET	INLET	520
C ESTIMATE THE INLET LENGTH CORRECTION DUE TO RADIATION	INLET	521
101 CORL(NN)=RHMINI(NN)/3.14159*ALOG(3.14159*BMINI(NN)/(SQRT	INLET	522
132.*AMINI(NN)/RHMINI(NN))*THELM)	INLET	523
1000 CONTINUE	INLET	524
C CONVERT THE HELMHOLTZ PERIOD TO HOURS	INLET	525
THELM=THELM/3600.	INLET	526
RETURN	INLET	527
END	INLET	528

SUBROUTINE HT1	INLET	529
C THIS SUBROUTINE WEIGHTS THE FLOW IN EACH SECTION SO THAT FRICTION	INLET	530
C IN THAT SECTION IS MINIMIZED. THIS MEANS THAT AT EACH SECTION FLOW IS	INLET	531
C ALLOWED TO REDISTRIBUTE ITSELF THROUGHOUT THE CHANNELS TO MINIMIZE FR	INLET	532
C HOWEVER, FLOW PERPENDICULAR TO THE CHANNELS IS ASSUMED TO BE SMALL AND	INLET	533
C FLOW IS NOT INCLUDED IN THE EQUATIONS OF MOTION, BY MINIMIZING FRICTI	INLET	534
C ROUTINE GIVES AN UPPER LIMIT FOR RAY LEVEL FLUCTUATIONS AND INLET VELO	INLET	535
REAL L,LENGTH,LTN,LX,N,NX	INLET	536
COMMON/NUMS/NI,G,NINLET,ICH(3),ISE(3),QR,L(7,7),B(7,7),D(7,7),	INLET	537
1 A(7,7),N(7,7),H(7,7),V(7,7),Q(7,7),HS,HB,H(7,7),IC,IS,AMINI(3),	INLET	538
IRMINI(3),LIN,QX(3),QINFLO,ABAY,LENGTH(3)	INLET	539
DIMENSION C(20)	INLET	540
DO 100 I=1,IS	INLET	541
SUMC=0.	INLET	542
DO 50 J=1,IC	INLET	543
C(J)=A(I,J)**2*(D(I,J)**.333)/	INLET	544
1 (N(I,J)**2*QX(NI)**2*B(I,J)*L(I,J))	INLET	545
50 SUMC=SUMC+C(J)	INLET	546
DO 60 J=1,IC	INLET	547
60 W(I,J)=C(J)/SUMC	INLET	548
100 CONTINUE	INLET	549
RETURN	INLET	550
END	INLET	551

	SUBROUTINE WT2	INLET	552
	C ROUTINE TO DETERMINE THE GRID *FIGHTING FUNCTION ASSUMING THAT	INLET	553
	C FLOW IN A GIVEN CHANNEL IS THE SAME ALONG THE ENTIRE CHANNEL	INLET	554
	C FLOW IS DISTRIBUTED IN CHANNELS TO GIVE A MINIMUM TOTAL FRICTION	INLET	555
	C FRICTION IN THIS ROUTINE WILL BE SLIGHTLY HIGHER THAN IN WT1 AND THE	INLET	556
	C IN THIS SYSTEM IS CONSISTANT WITH THE EQUATIONS OF MOTION.	INLET	557
	REAL L,LENGTH,LIN,LX,N,NX	INLET	558
	COMMON/NUMS/NI,G,NINLET,ICH(3),ISE(3),UR,L(7,7),B(7,7),D(7,7),	INLET	559
	1 A(7,7),N(7,7),W(7,7),V(7,7),Q(7,7),HS,HB,H(7,7),IC,IS,AMINI(3),	INLET	560
	1HMINI(3),LIN,QX(3),QINFLO,ABAY,LENGTH(3)	INLET	561
	DIMENSION C(20)	INLET	562
	SUMC=0.	INLET	563
	DO 100 I=1,IC	INLET	564
	C(I)=0.	INLET	565
	DO 50 J=1,IS	INLET	566
50	C(I)=C(I)+(N(J,I)**2*QX(NI)**2*(B(J,I)*L(J,I))/	INLET	567
	1 (A(J,I)**2+(D(J,I)**.333333))	INLET	568
	C(I)=1./C(I)	INLET	569
100	SUMC=SUMC+C(I)	INLET	570
	DO 70 J=1,IS	INLET	571
	DO 60 I=1,IC	INLET	572
60	W(J,I)=C(I)/SUMC	INLET	573
70	CONTINUE	INLET	574
	RETURN	INLET	575
	END	INLET	576
	 SUBROUTINE WT3	INLET	577
	C THIS ROUTINE ASSUMES THAT DISCHARGE IS EQUALLY DISTRIBUTED THROUGHOUT	INLET	578
	C THE INLET GRID SYSTEM. IN GENERAL THIS WILL NOT BE TRUE BECAUSE IT IS	INLET	579
	C DIFFICULT TO ACCURATELY DRAW THIS TYPE OF GRID BY EYE AND FLOW DISTRIB	INLET	580
	C CHANGES WITH TIME IN MOST INLETS. THIS ROUTINE IS USEFUL IN GIVING AN	INLET	581
	C VELOCITIES AND BAY LEVEL FLUCTUATIONS.	INLET	582
	C GRIDS WITH DEPTHS LT 0.01 FOOT ARE ASSUMED TO HAVE NO FLOW	INLET	583
	REAL L,LENGTH,LIN,LX,N,NX	INLET	584
	COMMON/NUMS/NI,G,NINLET,ICH(3),ISE(3),UR,L(7,7),B(7,7),D(7,7),	INLET	585
	1 A(7,7),N(7,7),W(7,7),V(7,7),Q(7,7),HS,HB,H(7,7),IC,IS,AMINI(3),	INLET	586
	1HMINI(3),LIN,QX(3),QINFLO,ABAY,LENGTH(3)	INLET	587
	DO 2 I=1,IS	INLET	588
	X=IC	INLET	589
	DO 1 J=1,IC	INLET	590
1	IF(N(I,J),LT,0.01) X=X-1.	INLET	591
	IF(X,LE,0.) WRITE(6,100) NI,IS	INLET	592
100	FORMAT(///,5X,(' ERROR == INLET HAS DRIED UP AS INDICATED IN WT3(,/'	INLET	593
	1 5X, (INLET=I,I4,(' SECTION=I,I4,///)	INLET	594
	IF(X,LE,0.) STOP	INLET	595
	DO 3 J=1,IC	INLET	596
	W(I,J)=1./X	INLET	597
3	IF(N(I,J),LT,0.01) W(I,J)=0.	INLET	598
2	CONTINUE	INLET	599
	RETURN	INLET	600
	END	INLET	601

	SUBROUTINE TARLF	INLET	602
C ROUTINE TO WRITE A TABLE OF INSTANTANEOUS HYDRAULICS		INLET	603
REAL L=LENGTH,LTN=LX,N,NX		INLET	604
COMMON/HUM5/NI,G,NINLET,ICH(3),ISE(3),OR,L(7,7),B(7,7),D(7,7),		INLET	605
1 A(7,7),N(7,7),W(7,7),V(7,7),D(7,7),HS,HB,H(7,7),IC,IS,AMINI(3),		INLET	606
1HMINI(3),LIN,DX(3),QINFLO,ARAY,LENGTH(3)		INLET	607
COMMON/NUM1/Y(5),DERY(5),X,NT,IWT,ZETA,HH		INLET	608
COMMON/NUM2/RX(3,7,7),DX(3,7,7),MX(3,7,7),WX(3,7,7),LX(3,7,7),NX(3		INLET	609
1,7,7)		INLET	610
COMMON/NUM4/RNK(3,4)		INLET	611
DIMPENSINN NAME(4)		INLET	612
DATA NAME/6HV(FPS) ,6HA(FT2) ,6HHEIGHT ,6HLEVEL		INLET	613
HHS=X/3600.		INLET	614
WRITE(6,1) HHS		INLET	615
1 FORMAT(1X,1-----=1, /		INLET	616
15X,1TIME, HOURS =1,F8,3)		INLET	617
DO 100 NI=1,NINLET		INLET	618
WRITE(6,10) NI,HS,HH,V(NI)		INLET	619
10 FORMAT(1,10X,1INLET,1I3,1,10X,1SEA LEVEL,FT=1,F7,2,1,10X,1BAY LEVE		INLET	620
1L,FT=1,F7,2,1,10X,1DISCHARGE,CFS=1,E10,4,1,2X,1CHANNEL SECT		INLET	621
110M 1 2 3 4 5 61)		INLET	622
IC=ICH(NI)		INLET	623
IS=ISE(NI)		INLET	624
DO 4 J=1,IC		INLET	625
DO 3 I=1,IS		INLET	626
A(I,J)=HX(NI,I,J)*(DX(NI,I,J)+MX(NI,I,J))+MX(NI,I,J)*ABS(HX(NI,I,J		INLET	627
1))/ZETA*FLUAT(IC)		INLET	628
IF(A(I,J),LT,0.01) A(I,J)=0.		INLET	629
V(I,J)=V(NI)*WX(NI,I,J)/A(I,J)		INLET	630
3 IF(A(I,J),LE,0.01) V(I,J)=0.		INLET	631
IF(J,EW,1) WRITE(6,50) J,NAME(4),(HX(NI,I,J),I=1,IS)		INLET	632
WRITE(6,69)		INLET	633
69 FORMAT(1)		INLET	634
WRITE(6,50) J,NAME(1),(V(I,I),I=1,IS)		INLET	635
50 FORMAT(4X,12,3X,AB,2X,6F10,2)		INLET	636
WRITE(6,50) J,NAME(2),(A(I,J),I=1,IS)		INLET	637
WRITE(6,50) J,NAME(3),(WX(NI,I,J),I=1,IS)		INLET	638
4 CONTINUE		INLET	639
WRITE(6,59) (HNK(NI,II),II=1,4)		INLET	640
59 FORMAT(5X,1TEMP ACC=1,F7,1,1 CONV ACC=1,F7,1,1 HEAD=1,F7,1,1 FRIC=		INLET	641
1,1,F7,1,1)		INLET	642
VBAR=V(NI)/AMIN(NI)		INLET	643
WRITE(6,61) VBAR,AMIN(NI)		INLET	644
61 FORMAT(5X,1MEAN VELOCITY AT THE MINIMUM AREA SECTION=1,F7,2,1 FT/S		INLET	645
1EC,1,1 AMIN=1,F9,2,1 FT2)		INLET	646
100 CONTINUE		INLET	647
RETURN		INLET	648
END		INLET	649

	SUBROUTINE CRIT(NT,DELT,IUNIT,T,NCYCLES)	INLET	650
C	SUBROUTINE CRIT COMPARES 3 CONSECUTIVE FUNCTION POINTS	INLET	651
C	AND WRITES MIDDLE POINT IF IT IS A CRITICAL POINT	INLET	652
C		INLET	653
	DIMENSION F(3,5),MARK(5),TERM(4)	INLET	654
	DATA MARKA/1H /, MARKB/1H//	INLET	655
	REWIND IUNIT	INLET	656
	NLINES=0	INLET	657
	TF=T/3600.	INLET	658
	WRITE(6,1009)	INLET	659
	DO 1 N=1,2	INLET	660
1	READ(IUNIT) X=(F(N,J),J=1,5)+(TERM(I),I=1,4)	INLET	661
	DO 100 N=3,NT	INLET	662
	READ(IUNIT) X=(F(3,J),J=1,5)+(TERM(I),I=1,4)	INLET	663
	IF(X,LT=-1,0E+10) GO TO 101	INLET	664
	IOUT=0	INLET	665
	DO 2020 IA = 1, 5	INLET	666
	MARK(IA) = MARKA	INLET	667
	IF (F(2,IA) = F(1,IA)) 2012, 2020, 2014	INLET	668
2012	IF (F(3,IA) = F(2,IA)) 2020, 2015, 2015	INLET	669
2014	IF (F(3,IA) = F(2,IA)) 2015, 2015, 2020	INLET	670
C	CRITICAL POINT VALUE FOUND	INLET	671
2015	IOUT = 1	INLET	672
	MARK(IA) = MARKB	INLET	673
	IF(TA,EO,1,AND,F(2,TA),GT,0.) HSH=F(2,IA)	INLET	674
	IF(TA,EO,1,AND,F(2,TA),GT,0.) T1=X	INLET	675
	IF(TA,EO,1,AND,F(2,TA),LE,0.) HSL=F(2,IA)	INLET	676
	IF(TA,EO,1,AND,F(2,TA),LE,0.) T2=X	INLET	677
	IF(TA,EO,3,AND,F(3,TA),GT,0.) HRH=F(3,IA)	INLET	678
	IF(TA,EO,3,AND,F(3,TA),GT,0.) T3=X	INLET	679
	IF(TA,EO,3,AND,F(3,TA),LE,0.) HHL=F(3,IA)	INLET	680
	IF(TA,EO,3,AND,F(3,TA),LE,0.) T4=X	INLET	681
	IF(TA,EO,4,AND,F(2,TA),LT,0.) VF=F(2,IA)	INLET	682
	IF(TA,EO,4,AND,F(2,TA),GT,0.) VF=F(2,IA)	INLET	683
2020	CONTINUE	INLET	684
	DO 2025 IA = 1, 5	INLET	685
	F(1,IA) = F(2,IA)	INLET	686
2025	F(2,IA) = F(3,IA)	INLET	687
	IF (IOUT,EO,0) GO TO 100	INLET	688
C	IF (X,LT,(NCYCLES=2)*TF) GO TO 100	INLET	689
	NLINES=NLINES+1	INLET	690
	IF(NLINES,GT,150) GO TO 100	INLET	691
	WRITE (6 ,2101) X=(F(1,IA),MARK(IA),IA=1,5)	INLET	692
100	CONTINUE	INLET	693
101	RENT	INLET	694
	AMPH=MBH/HSH	INLET	695
	AMPL=MBI/HSL	INLET	696
	PHM=ABS(T3=T1)*360./TF	INLET	697
	PHL=ABS(T4=T2)*360./TF	INLET	698
	WRITE(6,1011) AMPH,PHM,VF,AMPL,PHL,VF	INLET	699
	WRITE(6,1111) TF	INLET	700
1111	FORMAT(5X,(TF=(F7,2)	INLET	701
	RETIJRN	INLET	702
2101	FORMAT (2F8,3A1,=3FA,3A1,2(OPF7,3A1),	INLET	703
	3PF0,3A1, 2(FA,3A1))	INLET	704
1009	FORMAT(4X,4MTIME,5X,2MH5,4X,6MINFLO,5X,2MH8,	INLET	705
	1 5X,3MVEL7X,1HQ,/,5X,3MHHS,5X,2HFT,5X,4HKCF5,	INLET	706
	1 6X,2HFT,5X,3HFPS,4X,4HKCF5,)	INLET	707
1011	FORMAT(//,1X,1E CRITICAL POINT VALUE,/,//,15X,	INLET	708
	1 WAVE PROPAGATION(,/,15X,(AB/AD,15X,(PHASE LAG(DEG) MAX VEL,	INLET	709
	1//,2X,(HIGH WATER,2X,3F10,4,/,	INLET	710
	1 2X,(LOW WATER 1,2X,3F10,4)	INLET	711
	END	INLET	712

	SUBROUTINE READIN (X,Y,YFAC,XFAC,X0,XF,INDC,KK,LN,IUNIT)	INLET	713
C	SUBROUTINE TO READ SOLUTION TABULATION FROM FILE	INLET	714
C		INLET	715
	DIMENSION Y(9), YFAC(9)	INLET	716
	DT5=.5*1./60.	INLET	717
	READ (IUNIT) X, Y	INLET	718
	IF(X,LT,=1,E+10) KK=2	INLET	719
	INDC = 0	INLET	720
	IF (KK = 1) 10, 10, 50	INLET	721
10	IF (X0 = X = DT5) 20, 50, 50	INLET	722
20	IF (X = XF = DT5) 30, 25, 25	INLET	723
25	KK = 2	INLET	724
	GO TO 50	INLET	725
30	INDC = 1	INLET	726
	X = XFAC*(X = X0)	INLET	727
	Y(LN) = YFAC(LN)*Y(LN)	INLET	728
50	RETURN	INLET	729
	END	INLET	730
	SUBROUTINE GRPHC(ALABL1,ALABL2,DELT,IUNIT,NI)	INLET	731
C		INLET	732
C	SUBROUTINE GRPHC WRITES PLOTTER TAPE FOR GRAPHICAL	INLET	733
C	OUTPUT OF SOLUTION	INLET	734
C		INLET	735
	DIMENSION AL(2), ISYM(5)	INLET	736
	DIMENSION YLARLL(3),ALEGN(3,6),ALABL1(4),ALABL2(4),SYM(3),Y(9),YFA	INLET	737
	IC(9),XX(2000),YY(2000),TT(9,2)	INLET	738
	DATA YLARLL/10HHEIGHTS, V,10HVELOCITIES=.8H=FT, FPS/	INLET	739
	DATA ALEGN/10HFLOW (KFPS/10H) ,3H ,10HINLET VELO,10HCITY	INLET	740
	1 (FT/S,3HEC),10HMAX LEVEL(10HFT) ,3H ,10HINFLOW ,10H	INLET	741
	2 ,3H ,10HCOASTAL LEVE,10H(FT) ,3H ,10HLEGEND ,10H	INLET	742
	3 ,3H /	INLET	743
	DATA HL/10HUNSERVED H,10HMAX TIDE /	INLET	744
	DATA ISYM/5,4,3,2,1/	INLET	745
	DATA TT(6,1)/10HTEMPORAL A/	INLET	746
	DATA TT(6,2)/10HACCEL /	INLET	747
	DATA TT(7,1)/10HCONVECTIVE/	INLET	748
	DATA TT(7,2)/10H ACC /	INLET	749
	DATA TT(8,1)/10HPRESSURE H/	INLET	750
	DATA TT(8,2)/10HEAD /	INLET	751
	DATA TT(9,1)/10HBOTTOM STM/	INLET	752
	DATA TT(9,2)/10HSSH /	INLET	753
C		INLET	754
C	READ INFORMATION TO DIRECT PLOTTING	INLET	755
C		INLET	756
C	FIRST CARD	INLET	757
C	X0 = STARTING TIME OF PLOT (HRS)	INLET	758
C	XF = ENDING TIME OF PLOT (HRS)	INLET	759
C	SCALX = TIME AXIS SCALE IN HOURS PER INCH	INLET	760
C	YLO = MINIMUM VALUE OF TIDAL HEIGHTS (FT)	INLET	761
C	YL = OVERALL HEIGHT OF PLOT (INCHES)	INLET	762
C	YLSAL = SCALE OF TIDAL HEIGHTS (FT/INCH)	INLET	763
C	YRO = MINIMUM VALUE OF FLOWS (THOUSANDS OF CUBIC FEET PER SECOND)	INLET	764
C	YRSCAL = SCALE OF FLOW (THOUSANDS OF CUBIC FEET PER SECOND/INCH)	INLET	765
C		INLET	766
C	CARD 2	INLET	767
C	YVO = MINIMUM VELOCITY (FT/SEC)	INLET	768
C	YVSCAL = SCALE OF VELOCITY (FEET PER SECOND/INCH)	INLET	769
C	SCAL = SCALE FACTOR FOR TOTAL PLOT SIZE	INLET	770
C	IQ = NOT EQUAL TO ZERO FOR A PLOT OF INLET DISCHARGE	INLET	771
C		INLET	772

IF(NI,EO,1)	INLET	773
1 READ (5,2001) X0,XF,SCALX,YL0,YL,YLSCAL,YR0,YRSCAL,YV0,YVSCAL,	INLET	774
1 SCALE=IQ	INLET	775
2001 FORMAT(//F10.5,/,3F10.5,I10)	INLET	776
WRITE(6,2002) X0,XF,SCALX,YL0,YL,YLSCAL,YR0,YRSCAL,YV0,YVSCAL,	INLET	777
1 SCALE=IQ	INLET	778
2002 FORMAT(///,5X,(PLOT INFORMATION: ,/	INLET	779
1 1X,BF10.5,/,1X,3F10.5,I10)	INLET	780
C DETERMINE SYMBOL SPACING	INLET	781
LINTYP=.25*SCALX/(DELT/3600.)	INLET	782
WRITE(6,1215) LINTYP	INLET	783
1215 FORMAT(1X,(LINTYP=,I6)	INLET	784
C	INLET	785
E PLOT LEGEND	INLET	786
C	INLET	787
CALL SYMBOL(1,,-YL/2,=.8,2,6HLEGEND,0,16)	INLET	788
DO 20 LN = 1, 5	INLET	789
INDX = 0	INLET	790
YP=YL/2,=.8,LN,2	INLET	791
LLN=ISYM(LN)	INLET	792
CALL SYMBOL(0,YP,0,6,14,LLN,0,1)	INLET	793
SYM(1) = ALEGN(1,LN)	INLET	794
SYM(2) = ALEGN(2,LN)	INLET	795
SYM(3) = ALEGN(3,LN)	INLET	796
CALL SYMBOL(.4,YP,0,1 +SYM,0,23)	INLET	797
20 CONTINUE	INLET	798
C PLOT TITLE	INLET	799
CALL SYMBOL(3,5,=YL/2,-1,0,21,4LABL1,0,32)	INLET	800
CALL SYMBOL(3,5,=YL/2,-1,4,21,4LABL2,0,32)	INLET	801
C PLOT AXFS	INLET	802
YL0=YL/2,*,YLSCAL	INLET	803
CALL AXIS(0,,-YL/2,16HVELOCITY, FT/SEC,16,YL,90,*,YV0	INLET	804
1,YVSCAL)	INLET	805
CALL AXIS(=-.8,=YL/2,11HHEIGHTS, FT,11,YL,90,*,YL0,YLSCAL)	INLET	806
CALL AXIS(0,=YL/2,9HTIME, HRS=9,(XF=X0)/SCALX,0,*,0,*,SCALX)	INLET	807
IF(TQ,NE,0)	INLET	808
1CALL AXIS((XF=X0)/SCALX,=YL/2,10HFLOW, KCFS=10,YL +90,*,=YL/2,*YR	INLET	809
1SCAL,YRSCAL)	INLET	810
IF(TQ,EO,0) CALL PLNT((XF=X0)/SCALX,=YL/2,3)	INLET	811
IF(TQ,EO,0) CALL PLNT((XF=X0)/SCALX,YL/2,*,2)	INLET	812
CALL PLNT((XF=X0)/SCALX,YL/2,*,3)	INLET	813
CALL PLNT(0,*,YL/2,*,2)	INLET	814
YFAC(1) = 1./YLSCAL	INLET	815
YFAC(2) = 0./YVSCAL	INLET	816
YFAC(3) = YFAC(1)	INLET	817
YFAC(4) = 1./YVSCAL	INLET	818
YFAC(5) = YFAC(2)	INLET	819
DO 1234 II=0,9	INLET	820
1234 YFAC(II)=.003	INLET	821
XFAC = 1./SCALX	INLET	822
DO 85 I = 1, 9	INLET	823
80 IF I=0 DO NOT PLOT DISCHARGE	INLET	824
IF(TQ,EO,0,AND,I,EO,5) GO TO 85	INLET	825
COH=YL/2,+(I=5)*0.8	INLET	826
CALL PLNT (0,*, 0,*, 3)	INLET	827
KK = 1	INLET	828
ISUR=0	INLET	829
RE=IND TUNIT	INLET	830

	INDX = 0	INLET	831
65	CALL READIN (X,Y,YFAC,XFAC,X0,XF,INDC,KK,I,IUNIT)	INLET	832
	GO TO (70, 80), KK	INLET	833
70	IF (INDC,LE,0) GO TO 65	INLET	834
72	ISUR=ISUB+1	INLET	835
	IF (ISUB,GE,1998) ISUB=1998	INLET	836
	XX(ISUB)=X	INLET	837
	YY(ISUB)=Y(I)	INLET	838
	IF (I,GT,5) YY(ISUB)=YY(ISUB)+COR	INLET	839
	IF (ISUB,EG,1998) GO TO 80	INLET	840
	GO TO 65	INLET	841
80	XX(ISUB+1)=0,	INLET	842
	XX(ISUB+2)=1,0	INLET	843
	YY(ISUB+1)=0,	INLET	844
	YY(ISUB+2)=1,	INLET	845
C	PLOT CURVES (DO NOT PLOT IF EQUAL TO ZERO THROUGHOUT)	INLET	846
	IF (YY(ISUB+2),EQ,0,0,AND,	INLET	847
	1 YY(ISUB+1),EQ,0,0,AND,YY(ISUB),EQ,0,0) GO TO 85	INLET	848
	IF (I,GT,5) GO TO 885	INLET	849
	CALL LINE (XX,YY,ISUR+1,LINTVP,I)	INLET	850
	GO TO 85	INLET	851
885	CALL LINE (XX,YY,ISUR+1,0,0)	INLET	852
	CALL PLOT ((XF=X0)/SCALX,COR,3)	INLET	853
	CALL PLOT (0,0,COR+2)	INLET	854
	SYM(1)=TT(I+1)	INLET	855
	SYM(2)=TT(I+2)	INLET	856
	CALL SYMBOL (-2,2,COR,0,1,SYM,0,0,20)	INLET	857
85	CONTINUE	INLET	858
C	READ PHOTOTYPE RAY TIDE (DATA STARTS AT BEGINNING OF PLOT,SAME DATUM)	INLET	859
	IF (NI,NF,1) GO TO 2019	INLET	860
	HEAD(S,1) TDEL,NPTS	INLET	861
1	FORMAT(34X,F0,2,0X,I3)	INLET	862
	IF (NPTS,LT,2) GO TO 2019	INLET	863
	IF (NPTS,GT,1) READ(S,2) (YY(J),J=1,NPTS)	INLET	864
2	FORMAT(AF10,5)	INLET	865
	XX(NPTS+1)=0,	INLET	866
	XX(NPTS+2)=1,	INLET	867
	YY(NPTS+1)=0,	INLET	868
	YY(NPTS+2)=1,	INLET	869
	DO 3 J=1,NPTS	INLET	870
	YY(J)=YY(J)*YFAC(1)	INLET	871
3	XX(J)=(TDEL/60,1)*XFAC*(J=1)	INLET	872
	CALL PLOT (XX(1),YY(1),3)	INLET	873
	CALL LINE (XX,YY,NPTS+1,0,0)	INLET	874
	CALL PLOT (XX(NPTS/2),YY(NPTS/2),3)	INLET	875
	CALL PLOT (XX(NPTS/2),YY(NPTS/2)+.75,2)	INLET	876
	CALL SYMBOL (XX(NPTS/2)+.1,YY(NPTS/2)+.75,0,1,0L,0,0,17)	INLET	877
2019	CALL PLOT ((XF=X0)/SCALX*4,0,0,0,3)	INLET	878
	RETURN	INLET	879
	END	INLET	880

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